

THE
CYCLOPÆDIA;

OR,

UNIVERSAL DICTIONARY

OF

Arts, Sciences, and Literature.

BY

ABRAHAM REES, D.D. F.R.S. F.L.S. *S. Amer. Soc.*

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CYCLOPÆDIA:

OR, A NEW

UNIVERSAL DICTIONARY

OF

A R T S and S C I E N C E S.

WATER.

WATER. This important fluid was believed by the ancients to be one of the four elements out of which they imagined every other substance is composed. This opinion maintained its ground for a very long period. At length, however, it began to be suspected, from the experiments of Van Helmont, Boyle, and others. Van Helmont shewed that plants would grow for a very long time in pure water; whence it was concluded that water was capable of being changed into all the substances found in vegetables. Mr. Boyle supposed, that by long digestion and boiling in glass-vessels, he had converted water partly into an earth. Margraaff, who repeated his experiment, drew the same conclusion; but the opinion was never very generally admitted, and at length was proved to be erroneous, the earth being shewn to be derived from the glass-vessels employed in the experiments.

The combustible nature of hydrogen gas was observed about the beginning of the 18th century, and the celebrated Scheele, many years afterwards, was the first who attempted to discover what was produced by this combustion. In this, however, he did not succeed; nor were Macquer, Bucquet, Lavoisier, Dr. Priestley, and others, who subsequently repeated the experiment with similar views, more fortunate. The distinguished honour of discovering the composition of water was reserved for Mr. Cavendish, who, in 1781, proved beyond a doubt that the combustion of hydrogen and oxygen produced this fluid, and nothing else. Water, therefore, since the period just mentioned, has been universally admitted to be composed of these two gaseous principles.

Water is found in abundance in every part of the globe, and is absolutely necessary for the existence of organized beings. When quite pure, as obtained by distillation, it is

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perfectly transparent and colourless, and free from taste and smell.

A cubic foot of distilled water, according to the best experiments, weighs, at a temperature of 40°, 437102.4946 grains troy. Hence, a cubic inch of water at the same temperature weighs 252.952 grains; and at the temperature of 60°, 252.72 grains. The specific gravity of water is always supposed to be 1.000, and it is made the measure of the specific gravity of every other body. (See *SPECIFIC GRAVITY*, and *HYDROSTATICS*.) Water, at a temperature of 32°, becomes solid, and assumes the form of ice. In this state it possesses considerable hardness and elasticity, and its specific gravity is diminished to .94. See *FREEZING*, and *ICE*.

When water is raised to the temperature of 212° it boils, and is gradually converted into steam, which is an invisible and highly elastic fluid like air. The specific gravity of steam, according to the most recent observations, is .625, that of air being reckoned 1.000. See *BOILING*, *EBULLITION*, and *STEAM*.

Water is capable of undergoing a slight degree of compression. See *COMPRESSION*.

Water undergoes no alteration by exposure to heat or light. Thus it may be made to pass through a red-hot tube without suffering any change.

On exposure to the atmosphere, it absorbs a portion of air, the greater part of which is capable of being again driven off by boiling. To expel the whole, however, it is stated to be necessary to continue the operation at least two hours in a flask, with its mouth inverted over mercury. To this small proportion of air which it holds in solution, water chiefly owes its agreeable flavour, boiled water being insipid. See *ABSORPTION*, and *GAS*.

B

Hydrogen

Hydrogen gas, even at a red heat, has no action upon water. Charcoal, when cold, does not decompose it. But when red-hot charcoal is brought in contact with water, carbonic acid and carburetted hydrogen are formed in abundance. Sulphur and phosphorus do not appear to be capable of decomposing water, even when assisted by heat; but potassium and sodium, and doubtless also the metallic bases of the alkaline earths, decompose it rapidly. Of the other metals, iron, zinc, antimony, and tin, decompose it, when assisted by heat. Silver, gold, copper, and platina, produce no effect upon it.

Water dissolves the alkalies and alkaline earths. The acids also, and many saline compounds, are soluble in this fluid; but it is incapable of dissolving the earths properly so called.

Water combines with bodies in two different ways. It either dissolves them, in which case the proportion of water is unlimited, or it combines with them, and forms solid compounds, termed *hydrates*, into the composition of which the water enters in a definite proportion. The metallic hydrates, in general, are remarkable for the brilliancy of their colours. They are more soluble in acids than the oxyds, and in some instances affect the organs of taste even more perceptibly than the metallic salts. This subject has been particularly investigated by M. Proust. See *HYDRATE*.

According to the latest and most perfect experiments, water is composed of two volumes of hydrogen gas, and one volume of oxygen gas. Hence, its combining weight or atom will be 1.125, oxygen being reckoned 1; or, if we consider the specific gravity of hydrogen gas to be .6944, and of oxygen gas 1.1111, it is composed of one part by weight of hydrogen, and eight parts by weight of oxygen. The union of oxygen and hydrogen gases to form water is attended by the extrication of much light and heat. See *COMBUSTION* and *DETONATION*.

WATERS, Natural. "Water," says Dr. Saunders, "is found throughout the earth in every degree of purity, except the highest, for such is never procured, except by artificial distillation, as all natural waters are constantly coming into contact with some substance which they can either dissolve or hold suspended." Waters to which the epithet *mineral* is applied, in many instances differ from other natural waters in the degree only in which they are impregnated with similar foreign substances: in other instances, they differ in the nature of the impregnating ingredient; but for the most part they differ in both these circumstances. In presenting our readers with an account of natural waters in general, we shall commence with an enumeration and short account of the different foreign ingredients usually met with in waters, and influencing their operation on the animal economy.

1. *Caloric.*—The temperature of natural spring-waters is the same, in general, as the mean annual temperature of the particular place in which they occur. It is evident, therefore, that this temperature must vary with the latitude. (See the articles *CLIMATE*, *TEMPERATURE*, &c.) Waters rarely occur of a temperature much lower than the mean annual temperature of the latitude in which they are found; but instances are met with in every part of the globe in which they occur of a higher temperature. This degree of increased temperature is very different in different instances. Commonly it is not very striking, while in other cases it is very remarkable: thus, the waters of Carlsbad, in Bohemia, have the extraordinary temperature of 165°. In this country, the hottest springs are those of Bath and Buxton, the highest temperatures of which are stated to be 116° and 82° respectively. In some instances, these deviations from the natural temperature are obviously referrible

to the neighbourhood of volcanoes, but generally their cause is very obscure, as we can hardly form any idea of agents operating for such a length of time, and so uniformly, as those of necessity must do which give origin to the phenomena in question: all we can infer is, that although local, they are deep-seated and permanent.

2. *Atmospheric Air: Azote.*—All natural waters of a mean temperature hold a portion of common air in solution. The quantity, however, has been stated by Bergman not to exceed $\frac{1}{10}$ th of the bulk of the water; and even this can only be retained at a mean temperature, and under the ordinary pressure of the atmosphere, for the greater part of it escapes under the air-pump, or on submitting the water for a short time to a temperature of 212° or 32°. It is the oxygen contained in this small portion of atmospheric air, retained by water, that supports the respiration of fishes, and other aquatic animals, which speedily die from suffocation in water deprived of air. It is this air also, as before observed, which renders water sapid and grateful to the palate; for by boiling or distillation, this fluid is rendered insipid and disagreeable, "and has long been in disrepute," says Dr. Saunders, "for lying heavy on the stomach, and even producing scrofulous tumours and obstructions." The presence of atmospheric air in water is easily accounted for, from the affinity which subsists between the two substances, and which is such, that they soon become mutually impregnated by being exposed to each other.—Azotic gas has been found to exist in small quantity in some waters, and in these instances it has been observed to be extricated from the spring itself in union with the water. As far as is at present known, this gas imparts no medicinal or even sensible property to the waters containing it.

3. *Carbonic Acid.*—This gas is likewise stated by Bergman to exist in greater or less quantity in all natural spring-waters. The limits in which it occurs is said to lie between about $\frac{1}{1000}$, and an equal bulk of the water. In mineral waters it is a most important ingredient, not only from its operation upon the animal economy, but from its being the solvent of various other active ingredients. When waters contain this principle in excess, they assume a bright and sparkling appearance to the eye, have an agreeable pungent acidulous taste, and sometimes exert a kind of intoxicating power when largely drunk. Fishes are unable to exist in them, and speedily die from suffocation. On exposure to the air, however, these properties in a short time become sensibly diminished, and at length almost totally disappear, owing to the separation of the gas—an operation which may still more speedily be effected by boiling. The presence of this gas in water is easily explained, from its natural affinity to that fluid. In almost every instance it is extricated from the spring in union with the water; but the source from whence it is derived is, in general, obscure and inexplicable.

4. *Hydrogen and its Compounds, carburetted, sulphuretted, and phosphuretted Hydrogen.*—Hydrogen gas is barely soluble in water, and probably, therefore, never exists alone in that fluid. The same is true of carburetted hydrogen. Both these gases, however, are often extricated from waters, especially when stagnant, and containing organic substances in a state of putrefaction. Sulphuretted hydrogen is a frequent ingredient in mineral waters, and gives them so characteristic a feature, that they are instantly recognized. Waters holding this gas in solution have an offensive smell, like that of rotten eggs, or a foul gun-barrel, and which is more or less strong, according to the degree in which they are impregnated. Such waters also have a taste somewhat sweetish, and they generally appear turbid. Water, at a mean

mean temperature, is stated to absorb from $\frac{2}{3}$ ds to $\frac{1}{4}$ ths of its bulk of this gas, and by long agitation more than its bulk. At a temperature of 80° or 90° , however, this fluid can with difficulty be made to dissolve any of it. Sulphuretted waters, therefore, on exposure to heat, or even to the open air without heat, soon lose their characteristic properties, and become turbid, the hydrogen being dissipated, and the sulphur deposited. The source of this gas, in general, is not obscure, it being formed in great abundance during the decomposition of pyrites, and other minerals containing sulphur. Phosphuretted hydrogen is said to be occasionally extricated from marshes and stagnant pools, but it is not known to constitute an ingredient in mineral waters.

5. *The Alkalies and their Salts.*—The fixed alkalies seldom, if ever, occur in natural waters in a free state. Even the number of their salts is so limited, that Dr. Saunders thinks it necessary to enumerate only two, namely, the sulphate and muriate of soda. The first of them is a very common ingredient in mineral waters, but rarely occurs alone in any quantity, so that it can hardly be said ever to give a peculiar character to a water. Muriate of soda is so extensively and abundantly diffused through nature, that we rarely meet with a natural water which does not contain more or less of it. Sea-water, and many natural waters or *brines*, owe their peculiar characters to this salt, which has been known from the earliest times, and seems to be almost a necessary ingredient in our food. The muriate of soda, however, never occurs alone in natural waters, but is commonly accompanied by some of the earthy salts, especially the sulphate of lime. Chemists have been puzzled to account for the origin of the vast quantity of this salt which is met with in the sea and elsewhere; but a little reflection will shew, that the existence of this substance is not more difficult to be accounted for than that of any other ingredient of our globe. From its property of being soluble in water, it is, perhaps, more generally diffused than any other principle; but it is doubtful if it actually exists in greater abundance than silica, and many other solid substances, and which, in a geological point of view, differ from it only in the mechanical circumstance of their insolubility in water. The carbonate of soda is occasionally met with in waters. Its distribution, however, is very partial, being usually in very minute quantities, or in very large ones. When in small quantity, it is generally supersaturated with carbonic acid. The most remarkable instance of an excess of this salt is in “the natron lakes of Upper Egypt. It is here often mixed with common salt, and they both are largely dissolved in the water, and form a crust of several feet in thickness at the edge of the lake, owing to the copious evaporation of their water of solution effected by a tropical sun.” Potash, or its salts, very seldom occur in mineral waters. Carbonate of ammonia is occasionally found in small quantities in some waters, arising probably, as Dr. Saunders conjectures, from decomposed animal or vegetable substances.

6. *The Earths and their Salts.*—The earth most frequently occurring in natural waters is lime, and so generally is this the case, that very few instances are known in which this earth is not met with in some state or other. The neutral carbonate of lime, or *chalk*, is one of the most insoluble substances known; but the supercarbonate of lime is very soluble, and is a frequent ingredient in many springs. “It is one source of *hardness* in waters,” says Dr. Saunders, “but is easily got rid of by boiling, which drives off the excess of carbonic acid, and thus causes the chalk to be precipitated; hence the earthy crust or *furr* on

kettles in which hard water has been boiled for a number of times. Some natural waters contain an unusual quantity of this calcareous earth, which is rapidly deposited as soon as they become exposed to the air, and thereby give an earthy lining to every tube through which they flow, and encrust with the same material every substance that accident or design may put in their way. Of this kind are the various petrifying springs that form part of the natural curiosities of several mountainous districts, and have been applied to use in a very ingenious manner at the baths of St. Philip, in Tuscany, and still more extensively at Gualecavelica, in Peru.”—“The sulphate of lime (the gypsum or selenite of the older writers) is one of the commonest of all the earthy salts that are found in natural waters, and generally accompanies every saline substance, except where there is an excess of alkali. It is almost invariably found in conjunction with the carbonate of lime; and hence the calcareous depositions, petrifications, and the like, frequently contain a small admixture of selenite.” This salt imparts very little taste to water, but gives it “that rough and harsh feel to the fingers and tongue, which characterize the insipid *hard* waters.” The muriate of lime commonly accompanies the other salts of lime, but especially the muriate of soda. When in excess in any water, it imparts to it a bitter and disagreeable taste, and active medicinal properties. The great bitterness of “the waters of the Dead sea is owing to the muriates of lime and magnesia, and not to bitumen, as was erroneously supposed.” The carbonate of magnesia is insoluble in water; the supercarbonate of magnesia, when it occurs in waters, is always accompanied by the supercarbonate of lime, both the earths being held in solution by an excess of carbonic acid. The supercarbonate of magnesia, however, is more soluble than the supercarbonate of lime, and is not, therefore, so easily separated by boiling. The sulphate of magnesia, or *Epsom* salt, as it was formerly denominated, is the most important of the salts of this earth. It almost always accompanies the sulphate of soda; and to these two salts most of the natural purging waters owe their cathartic properties. It is likewise frequently combined with the sulphate of lime, and also with iron. The sulphate of magnesia imparts to the waters containing it in any considerable quantity a strongly bitter and saline taste. It was first discovered in a spring at Epsom, whence its name; but is usually prepared at present from the refuse salt of sea-water, after the common salt has been separated. The muriate of magnesia, as before-mentioned, commonly accompanies the muriates of soda and lime; hence it is found in various brine-springs, and forms a considerable part of the saline contents of sea-water, to which fluids, especially when concentrated by evaporation, it imparts a strong bitter taste. Salts of alumina are not of very frequent occurrence in waters. The most common is the superphosphate of alumina, or common alum, which is usually associated with the sulphate of iron. The source of this salt is for the most part alum-slate, the sulphur contained in which becomes acidified on exposure to the air, and forms sulphuric acid, which, uniting with the alumina, produces the salt in question. The presence of the sulphate of iron is easily accounted for upon similar principles, since more or less of iron pyrites almost invariably accompanies alum-slate. Silica, in a state of minute division, is sometimes found suspended in small quantity in running waters, but is soon deposited on their remaining at rest. This earth, however, occasionally occurs in a state of solution in hot and tepid springs, especially in the neighbourhood of volcanoes. The menstruum appears to be usually a little free or carbonated alkali, the solvent

powers of which are doubtless much increased by heat, or by some unknown cause.

7. *Metals and their Salts.*—The metal most usually met with in natural waters is iron; never, however, in its metallic state, but in a state of oxyd combined with an acid. The carbonate of iron is a frequent ingredient of natural waters, the base of which is the black or protoxyd of the metal, for the red oxyd does not seem capable of combining with carbonic acid, or at least of forming with it a soluble compound. This is, doubtless, a wise provision of nature; for, as Dr. Saunders justly observes, if the contrary were the case, almost every natural water would be a chalybeate. The carbonate of iron, like all the other salts of this metal, imparts to waters containing it a peculiar inky taste, “which,” says Dr. Saunders, “is very perceptible, even when the proportion of iron is so small as hardly to be estimable by any chemical process.” Waters containing the carbonate of iron deposit this metal readily on exposure to the air, partly from the escape of the carbonic acid, and partly from the further oxydation of the metal. The sulphate of iron or green vitriol is met with occasionally in waters in considerable quantity. This salt, as before observed, generally occurs in union with the sulphate of alumina, or alum, and is the natural production of the decomposition of iron pyrites. Waters containing this salt in any quantity, possess the properties of chalybeates in a high degree, and are peculiarly styptic. The muriate of iron is occasionally met with in natural waters; but its existence in any considerable quantity is a rare occurrence. *Copper*, or rather its salts, and especially the sulphate of copper, is occasionally met with in natural waters. This generally, however, occurs in the neighbourhood of copper-mines; and the sulphate of copper, as Dr. Saunders observes, is probably formed, like the sulphate of iron, by the decomposition of copper pyrites. Waters containing this metal are highly poisonous, and are never used internally. *Manganese* is occasionally found in small quantity in natural waters. It appears, in general, to be associated with iron; but the state in which it exists is not accurately known. As far as present observation goes, it imparts no sensible or other properties to the waters containing it. *Lead*, perhaps, never naturally occurs in waters; but some waters have the property of dissolving, or holding in suspension, a minute portion of this pernicious metal, when exposed to it in the metallic state. Pure soft waters are said to possess this property in the most striking degree.

8. *Mineral Acids.*—Both the muriatic and sulphuric acids are occasionally met with in mineral waters in a free state. Such springs usually occur in volcanic countries.

9. *Bitumen.*—Bitumen is said by many of the older writers to be a frequent ingredient in mineral waters. This statement, however, has been generally found erroneous by modern chemists, who have in most cases demonstrated the supposed bituminous principles of their predecessors to be substances of a very different nature. There are some springs, however, which yield a real bitumen; but this, from its insolubility in water, is never dissolved in that fluid, except in a few rare instances, through the medium of an alkali.

Such is a short account of the principal mineral substances which are met with in natural waters when they issue from the earth. “When,” says Dr. Saunders, “they flow within a channel over the surface of the ground, they often become much changed in their chemical composition, losing some of their contents by evaporation, others by slow deposition, or by being decomposed through the influence of light and air. At the same time they often acquire new

contents, which are furnished by the soil over which they flow. Thus the streams which pass over a country covered with vegetable matter, or which water large towns, will contain a sensible quantity of mixed alluvial contents, or a heterogeneous compound of animal and vegetable extract of mucilage.

Different authors have chosen different principles of arrangement in treating of natural waters. An arrangement purely chemical, or purely medicinal, cannot be effected in the present state of our knowledge; we shall not therefore attempt either, but shall consider them under the following heads:

1. Potable waters.
2. Saline waters.
3. Chalybeate waters, simple and compound.
4. Acidulous waters, simple and compound.
5. Sulphurous waters, simple and compound.
6. Thermal waters, simple and compound.

This arrangement of natural waters, according to their *sensible* properties, coincides likewise, as well perhaps as the present state of the subject will admit, with their *chemical* and *medicinal* properties. It may, however, be objected to the divisions *simple* and *compound*, that neither of them is accurately correct, and this must be admitted in a strictly chemical point of view; but taken in the enlarged and general sense here understood, there seems to be no serious objection to this mode of division.

1. *Potable Waters.*—Under this division we wish to include every variety of this fluid ordinarily used by mankind and other animals for satisfying their thirst. These may be comprehended under the heads of, *a*, pure or distilled water; *b*, atmospheric water; *c*, spring-water; *d*, running water; and *e*, stagnant water.

a. The chemical properties of pure water have been already described at the head of this article. As before observed, it never occurs in nature, and was therefore probably never intended as an article of drink for mankind; certainly, at least, not as one absolutely necessary for their existence, or even healthy condition.

b. Under *atmospheric* waters are included rain-water, snow-water, dew, &c.

Rain-water, collected at a distance from large towns, or any other object capable of impregnating the atmosphere with noxious materials, approaches more nearly to a state of purity than perhaps any other natural water. Even collected under these circumstances, however, it invariably yields traces of the muriatic acid, and, according to Margraaff, of the nitric also. Rain-water of course differs according to the state of the atmosphere through which it passes. “The heterogeneous atmosphere of a smoky town,” says Dr. Saunders, “will communicate some impregnation to rain as it passes through; and this, though it may not be at once perceptible on chemical examination, will yet render it liable to spontaneous change: and hence rain-water, if long kept, especially in hot climates, acquires a strong smell, becomes full of animalculæ, and in some degree putrid.” Rain-water in general, in warm climates, is much more impure and liable to become offensive than in cold and temperate ones. Rain also that falls in the spring and summer, or after a long-continued drought, or very hot weather, is said to be more impure than that which falls at other seasons of the year, or after a long-continued moist season; circumstances, doubtless, owing to the existence of a greater proportion of animal and vegetable principles in the atmosphere in such climates and seasons. These foreign substances have sometimes been so abundant and peculiar in their appearance, as

to have given origin to many marvellous stories, such as the raining of blood, &c. (See the article RAIN.) The specific gravity of rain-water hardly differs from that of distilled water; and from the minute portions of the foreign ingredients which it generally contains, it is very soft, and admirably adapted for many culinary purposes, and various processes in different manufactures and the arts.

Snow-water equals, if not surpasses, rain-water in purity, when collected under the same circumstances, it being for obvious reasons more free from animal and vegetable impregnations; thus Dr. Ruttly found it perfectly sweet after keeping it in a close vessel for eighteen months. Snow-water, like rain-water, even in its purest state, yields traces of muriatic acid, and perhaps also of the nitric.

Hail-water may be compared to snow-water, which it closely resembles: indeed

Ice-water in general is very pure, as the air and saline substances are separated by freezing. Common ice-water, however, is less pure than rain and snow water, as the foreign substances, though perhaps separated by freezing, still remain incorporated with the ice, so that it is impossible to melt the ice without retaining at least a portion of these foreign matters.

Dew, being deposited chiefly from the lower parts of the atmosphere, is commonly much more impure than rain or snow water. According to Dr. Ruttly's observations, it soon becomes fetid and offensive. It yields also more sensible traces of the presence of muriatic acid than rain-water. This fluid, however, collected at different places and times, differs exceedingly in its properties, as might be naturally expected.

c. Spring-water includes *well-water*, and all others that arise from some depth below the surface of the earth, and which are used at the fountain-head, or at least before they have run any considerable distance exposed to the air. Although all spring-waters are originally of atmospheric origin, yet they differ from one another according to the nature of the soil or rock from which they issue; for though the ingredients usually existing in them are in such minute quantities as to impart to them no striking medicinal or sensible properties, and do not render them unfit for common purposes, yet they modify their nature very considerably. Hence the water of some springs is said to be *hard*, others *soft*, some *sweet*, others *brackish*, &c. according to the degree and nature of the impregnating ingredients. Common springs pass insensibly into mineral or medicinal springs, as their foreign contents become larger or more unusual; or in some instances they derive medicinal celebrity from the absence of those ingredients usually occurring in spring-water; as, for example, is the case with the Malvern and other springs. Almost all spring-waters possess the property termed *hardness* in a greater or less degree. This hardness, as we formerly mentioned, depends chiefly upon the sulphate and carbonate of lime which they hold in solution. The quantity of these earthy salts varies very considerably in different instances; but Dr. Saunders observes, that when they exist in the proportion of five grains in the pint, such water will be hard, and from its property of decomposing soap will be unfit for washing, and many other purposes of household use or manufactures. The water of deep wells, according to Dr. S., is always, *ceteris paribus*, much harder than that of springs which overflow their channel; but there are many exceptions to this rule. The *softness* of spring-waters depends on their containing smaller proportions of the earthy salts above-mentioned. Spring-waters are said to be brackish, when they contain a small proportion of the muriates of soda, magnesia, or lime, as is frequently the case in the neighbourhood of the sea.

Sweetness is generally understood as opposed to *brackishness* or *factor* when applied to spring-waters. The specific gravity of spring-waters in general is greater than that of distilled or any other potable water. See SPRING.

d. Running waters include *river-waters*, and every other species of water exposed to the air, and moving in an open channel. On this part of our subject we cannot do better than quote from Dr. Saunders. "River-water," says Dr. S., "in general is much softer, and more free from earthy salts than spring-waters, but contains less air of any kind; for by the agitation of a long current, and, in most cases, a great increase of temperature, it loses common air and carbonic acid, and with this last much of the lime which it held in solution. The specific gravity thereby becomes less, the taste not so harsh, but less fresh and agreeable, and out of a hard spring is often made a stream of sufficient purity for most of the purposes where a soft water is required. Some streams, however, that arise from a clean silicious rock, and flow in a sandy or stony bed, are from the outset remarkably pure, such as the mountain lakes and rivulets in the rocky districts of Wales, the source of the beautiful waters of the Dee, and numberless other rivers that flow through the hollow of every valley. Switzerland has long been celebrated for the purity and excellence of its waters, which pour in copious streams from the mountains, and give rise to some of the finest rivers in Europe."—"Some rivers, however, that do not take their rise from a rocky soil, and are indeed at first considerably charged with foreign matter, during a long course, even over a richly cultivated plain, become remarkably pure as to saline contents, but often fouled with mud and vegetable or animal exuvia, which are rather suspended than held in true solution. Such is that of the Thames, which, taken up at London at low water, is very soft and good water, and after rest and filtration it holds but a very small portion of any thing that could prove noxious, or impede any manufacture. It is also excellently fitted for sea-store, but it here undergoes a remarkable spontaneous change. No water carried to sea becomes putrid sooner than that of the Thames. When a cask is opened, after being kept a month or two, a quantity of inflammable air (carburetted or sulphuretted hydrogen) escapes, and the water is so black and offensive as scarcely to be borne. Upon racking it off, however, into large earthen vessels, and exposing it to the air, it gradually deposits a quantity of black slimy mud, becomes clear as crystal, and remarkably sweet and palatable. The Seine has a high reputation in France, and appears, from the experiments of M. Parmentier, to be a river of great purity. It might be expected that a river which has passed by a large town, and received all its impurities, and been used by numerous dyers, tanners, hatters, and the like, that crowd to its banks for the convenience of plenty of water, should acquire thereby such a foulness as to be very perceptible to chemical examination for a considerable distance below the town; but it appears from the most accurate examination, that where the stream is at all considerable, these kinds of impurity have but little influence in permanently altering the quality of the water, especially as they are for the most part only suspended, and not truly dissolved; and therefore mere rest, and especially filtration, will restore the water to its original purity. Probably, therefore, the most accurate chemist would find it difficult to distinguish water taken up at London from that procured at Hampton-court, after each had been purified by simple filtration." The water of the Ebro also, notwithstanding this river passes through several large towns, is remarkable for its purity. In general, those rivers which issue from lakes are most pure and transparent, while those chiefly supplied

supplied by springs and rain are the reverse. The water of some rivers is remarkable for its colour: thus that of the Tinto, in Spain, at its source is of a fine topaz, a circumstance from which the river takes its name. Others are of a yellowish or greyish-white, and the water of all such rivers usually holds a large proportion of some salt of lime in solution. In countries where bogs and marshes abound, the rivers are often tinged of a brownish colour.

e. Stagnant Waters.—Under this head are included the waters of lakes, pools, and reservoirs of every description, in which this fluid is exposed to the air in a state of rest. Stagnant waters, in general, present greater impurities to the senses than any others, from their usually containing a large proportion of animal and vegetable matters in a state of decomposition. Their taste in general is vapid, and destitute of that freshness and agreeable coolness which distinguish spring-water. Stagnant waters have various origins, but usually they are a mixture of rain, spring, and river water; and hence, besides the animal and vegetable matters they contain, may be supposed to be impregnated with the various saline matters usually met with in such waters. Many stagnant waters are said to contain the nitrate of potash; others, and especially some lakes, abound in the sulphate of magnesia; others in the carbonate of soda, as, for example, the natron lakes of Egypt and Hungary, which are generally very shallow. A lake in Thibet is impregnated with the borate of soda mixed with the muriate of soda, the waters of which seem to have a subterranean origin. Some lakes also are found impregnated with sulphuretted hydrogen gas. Stagnant waters are seldom perfectly colourless and transparent. Lakes, when deep, are usually of a blueish tinge, mixed with green; and when the neighbouring hills are covered with peat, &c. their water is always of a muddy-brownish tinge, as, for example, is the case with most of the lakes in Scotland.

1. *Uses of Potable Waters.*—If we were to be directed by the evidences of the senses alone, *spring*-waters would undoubtedly be pronounced to be the most wholesome, for they are universally admitted to be the most agreeable. All other waters have more or less of a flat insipid taste. This is especially the case with *distilled* and *rain* water; the first of which is quite pure, and the second nearly so. *Distilled* water, therefore, is seldom employed for drinking; and the difficulty of procuring it in large quantities almost precludes its use to any extent in the preparation of food, or in manufactures. Much, however, has been lately said of its medicinal powers by Dr. Lambe, who has recommended it in cancerous and other affections; and, as Dr. Saunders justly observes, water, when not already loaded with foreign matters, may become a solvent for concretions in the urinary passages; and as much good has been obtained from the use of very pure natural springs, a course of distilled water may be considered as a fair subject of experiment. *Distilled* water is an essential ingredient in the composition of many medicines, and often absolutely necessary in the prosecution of all nicer chemical processes in the liquid way. *Snow* and *ice* water form almost the constant drink of the inhabitants of cold climates during winter; and the masses of ice which float on the polar seas afford an abundant supply of fresh water to the mariner. “*Snow-water*,” says Dr. Saunders, “has long lain under the imputation of occasioning those strumous swellings in the neck which deform the inhabitants of many of the Alpine valleys; but this opinion is not supported by any well-authenticated indisputable facts, and is rendered still more improbable, if not entirely overturned, by the frequency of the disease in Sumatra, where ice and snow are never seen, and its being quite unknown in Chili and

Thibet, though the rivers of those countries are chiefly supplied by the melting of the snow with which the mountains are always covered.” *Dew*, especially when collected in the month of May, was formerly in great repute as a cosmetic, and for many other purposes; but its use has been long entirely laid aside. *Spring*-waters, as before observed, from the air they contain, and from their grateful coolness, constitute by far the most agreeable of the potable waters, and are in more general use than any others. Their use, however, is stated sometimes to occasion in delicate stomachs an uneasy sense of weight, followed by a degree of dyspepsia. They have also been accused, especially when of the description termed *hard*, of inducing calculous affections; but this notion by most modern writers is considered as ill-founded. *Spring*-waters, in general, also, from their property of hardness, are, as before observed, very ill adapted for many domestic and other purposes; while, in particular instances, this quality is of advantage. *Hard spring*-waters, for example, are very ill adapted for the purposes of the dyer or bleacher. “On the other hand,” says Dr. Saunders, “there are several saline substances which are very readily soluble in any kind of water, and here a hard water may be employed when the object is only to procure these particular salts. For culinary purposes, water is used either to soften the texture of animal or vegetable matter, or to extract from it, and present in a liquid form some of its soluble parts. Soft pure water will fulfil both these objects better than hard water; and at the same time the colour of the substance employed will vary as well as its solution. Green vegetables and pulse are rendered quite pale, as well as tender, by boiling in soft water; whereas in a hard water, the colour is more preserved, and the texture less altered, because in the former case the colouring matter of the vegetable is readily extracted by the menstruum, whilst in the latter more of it remains, and is likewise altered by the chemical action of the earthy or neutral salts.” Dr. S. then relates some comparative experiments he made with hard and pure water upon tea; from which he concludes that hard water is less powerful in softening the texture of vegetable leaves than soft water, and that it is not able to exert its full effect in heightening their colour till assisted by heat; and also, that the gallic acid (or tannin) is equally well extracted by hard as by soft water, when by raising the temperature, the power of the former as a solvent is fully exercised. It may be therefore laid down as a general rule in domestic economy, that when the object is to extract the virtues of any substance, and to retain them in solution, *soft* waters should be used; but that when the object is the reverse, or to preserve as entire as possible the article used as food, *hard* waters are preferable.

Some fine springs of very pure and soft water have been long celebrated for their medicinal properties; as, for example, the *Malvern* springs, in Worcestershire, and *St. Winifrid's Well*, at Holywell, in Flintshire. *Malvern* water is used both externally and internally. Externally applied, it is stated to be a most useful application to deep-seated ulcerations of a scrofulous nature, and to various cutaneous affections. Its internal use is often of advantage “in painful affections of the kidneys and bladder, attended with the discharge of bloody, purulent, or fœtid urine; the hectic fever produced by scrofulous ulcerations of the lungs, or very extensive and irritating sores on the surface of the body; and also fistulas of long standing, that have been neglected, and have become constant and troublesome sores.” The internal use of this water sometimes induces nausea at first, and occasionally drowsiness, vertigo, and head-ache, which soon go off, or may be readily removed by a mild purgative,

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purgative. This water occasionally purges, but most commonly the body becomes costive under its use. "In all cases, it increases the flow of urine, and improves the general health of the patient; so that his appetite and spirits almost invariably improve during a course of the water, if it agrees in the first instance." The duration of a course of this water depends in a great degree upon the nature of the disease under which the patient labours. These observations upon the effects of the Malvern water are perhaps equally applicable to all spring-waters of a similar degree of purity.

What has been said of spring-waters may be applied perhaps with little modification to *running* waters, which in general differ from *spring*-waters only in being softer, in containing less air, and in being therefore better qualified for many purposes for which spring-waters cannot be employed. *Stagnant* waters in general, especially in marshy countries and hot climates, are usually esteemed unwholesome, and perhaps deservedly so. This arises chiefly from the large quantity of vegetable and animal exuviae which they contain, and perhaps from other circumstances of which we are at present ignorant. They should never be used, therefore, till they have been boiled and filtered; by which processes most of the foreign substances will be probably removed. In general stagnant waters, as Dr. Saunders observes, are unpalatable; and this circumstance has probably caused them to be sometimes in worse credit than they actually deserve to be on the score of salubrity.

2. *Simple saline Waters.*—Under this denomination we include all those waters impregnated with neutral, alkaline, and earthy salts only. Waters of this description may be arranged under the following heads:—*a.* Brines, or waters whose principal saline ingredients are the muriates of soda and magnesia; and *b.* Bitterns, or waters containing principally the sulphates of soda and magnesia.

a. Sea-water, which may be considered as an example of the saline waters termed brines, is one of the most abundant and extensively diffused compounds occurring upon our globe. When taken up at a considerable distance from the shore it is quite transparent and colourless, and free from any smell. Its taste is strongly saline, and at the same time nauseous and bitter. When kept for a short time it becomes highly offensive, from the putrefaction of the animal and vegetable matters which it holds in solution. Its specific gravity varies in different latitudes and circumstances, but may be said to lie between 1.0269 and 1.0285. The specific gravity is said to be less within the polar circles than at the tropics, owing probably to the vast quantities of ice found in those regions. The waters of inland seas also, that have little connection with the ocean, and the water of bays, &c. into which fresh-water rivers empty themselves, contain in general less saline matters than the open ocean. This is particularly the case with the Baltic, especially when the wind blows from the east. The Mediterranean sea, on the contrary, is said to be more saline than the Atlantic. Water taken from a considerable depth is more saline than that taken from the surface, particularly after much rain, for rain-water being lighter appears to move upon the surface for a considerable time before it becomes quite incorporated. The quantity of saline matter also is stated to be greater in summer than in winter. The water of the British coasts is said to contain upon an average about one-thirtieth of its weight of saline matter, and its temperature to vary between 40° and 65°. Sea-water does not freeze till cooled down to 28.95°. The following is one of the latest analyses of sea-water by Dr. Murray. A

wine pint of water collected in the Firth of Forth was found to contain

	Grains.
Of lime	2.9
Magnesia	14.8
Soda	96.3
Sulphuric acid	14.4
Muriatic acid	97.7
	226.1

Or, supposing the elements to be combined in the modes in which they are obtained by evaporation; that is, as muriate of soda, muriate of magnesia, sulphate of magnesia, and sulphate of lime, the proportions of these salts in a pint will be,

	Grains.
Muriate of soda	180.5
— of magnesia	23.0
Sulphate of magnesia	15.5
— of lime	7.1
	226.1

Or, supposing that the lime exists as muriate of lime, (which is the most probable conclusion with regard to it); and farther, supposing that the sulphuric acid exists in the state of sulphate of magnesia, the proportions will be,

	Grains.
Muriate of soda	180.5
— of magnesia	18.3
— of lime	5.7
Sulphate of magnesia	21.6
	226.1

Or, lastly, supposing that the sulphuric acid exists in the state of sulphate of soda, the proportions will be,

	Grains.
Muriate of soda	159.3
— of magnesia	35.5
— of lime	5.7
Sulphate of soda	25.6
	226.1

The bitter taste of sea-water is owing chiefly to the muriate of magnesia which it contains. It may also arise, in part, from the presence of decayed vegetable and animal substances. See the articles SALT, SALTNESS, and SEA.

Many attempts have been made to render sea-water potable. Of these the best, and indeed the only good one, is distillation.

The method of obtaining fresh water from the distillation of sea-water was practised by sir R. Hawkins, in the reign of queen Elizabeth, who thus obtained water that was wholesome and nourishing. See Purchas's Collect. of Voyages, book vii. chap. 5.

Experiments were afterwards made by Hales, Lister, Hanton, Lind, and others, to simplify and render more perfect the process of distillation, and at length it attained a great degree of perfection, both in France and England. Thus M. de Bougainville, in his Voyage round the World, bore ample testimony to the utility of the machine for distilling sea-water, which had been made public in 1763 by M. Poissonnier, its inventor; and lord Mulgrave, in his Voyage

Voyage towards the North Pole, in 1773, did equal justice to the method of obtaining fresh water from the sea by distillation, which had been introduced into the English navy in 1770, by Dr. Irving, and for which he obtained a parliamentary reward of 5000*l*.

Dr. Irving's contrivance consisted in converting the ship's kettle into a still. Every ship's kettle is divided into two parts, by a partition in the middle; one of these parts is only in use when peas or oatmeal are dressed, but water is at the same time kept in the other, to preserve its bottom. Dr. Irving availed himself of this circumstance; and by filling the spare part of the copper with sea-water, and fitting on the lid and tube, shewed that sixty gallons of fresh water could be drawn off, during the boiling of either of the above-mentioned provisions, without the use of any additional fuel. He recommended also the preserving of the water distilled from the coppers in which peas, oatmeal, or pudding, are dressed, as both a salutary beverage for the scorbutic, and the most proper kind of water for the boiling of salt provisions. Dr. Irving particularly directed that only three-fourths of the sea-water should be distilled, as the water distilled from the remaining concentrated brine was found to have a disagreeable taste; and as the farther continuation of the distillation proved injurious to the vessels. For an account of the several experiments made on some of the best distilled water, prepared by Dr. Irving from sea-water, by Dr. Watson, see his *Chem. Ess.* vol. ii. p. 163, &c.

The ships of discovery lately sent out by the French government are furnished with an economical distilling apparatus, and instead of water have taken with them a supply of fuel.

Dr. Priestley suggested a plan to give to distilled water the briskness and spirit of fresh spring-water, and at the same time to render it, perhaps, a remedy or preventive against the scurvy, by impregnating it with carbonic acid gas. Distilled water also acquires, in a considerable degree, the grateful flavour of common water, by simple exposure for some time to the atmosphere.

Sea-water may be likewise rendered potable by converting it into ice. In the polar regions, therefore, there can be no want of fresh water. In warm climates, the ingenious freezing apparatus of Mr. Leslie may be employed to procure a supply of fresh water from the ocean.

b. As an example of the bitters we may select the *Sedlitz water*, which is one of the best known, and strongest of this description of simple saline waters. Sedlitz is a village in Bohemia, and its waters, as well as those of Seydschutz in the immediate neighbourhood, and which closely resemble them, were first brought into note about a century ago by the celebrated Bergman. The taste of these waters is strongly bitter and saline, but not in the least brisk or acridulous, as they usually contain a small proportion of gaseous matters. Thus the Seydschutz water above-mentioned was found by Bergman to yield only 6 per cent. of gaseous products, two-thirds of which only were carbonic acid. Its specific gravity, as stated by the same chemist, is 1.006, and an English wine pint was found to contain of

		Grains,
Carbonate of lime	-	.944
Sulphate of lime	-	5.140
Carbonate of magnesia	-	2.622
Muriate of magnesia	-	4.567
Sulphate of magnesia	-	180.497
		193.770

Sulphate of soda is not mentioned as an ingredient in this water, although it doubtless exists in it; at least this salt almost always occurs in waters of this description.

Medicinal Properties and Uses of the simple saline Waters.—

All waters of this description act more or less strongly upon the bowels, according to the quantity of saline ingredients which they contain; hence they are often of the greatest use in complaints where alvine evacuations are particularly indicated. They generally act also as diuretics. Sea-water and all brines have the property of inducing a sensation of thirst. "Sea-water," says Dr. Saunders, "when used internally, should be taken in such doses as to prove moderately purgative, the increase of this evacuation being the peculiar object for which it is employed: about a pint is generally sufficient, and this should be taken in the morning, at two doses, with an interval of about half an hour between each. It is seldom necessary to repeat the dose at any other time of the day. This quantity contains half an ounce of purgative salt, of which about three-fourths are muriate of soda."—"There is very little danger ever to be apprehended from an excessive dose of sea-water, except the inconvenience of a temporary diarrhoea, and sometimes a foreness at the extremity of the rectum, which all saline purgatives are now and then apt to produce." The internal use of sea-water, besides its general use in diseases where cathartics are indicated, has been recommended in various forms of scrofulous affection, especially in indolent glandular tumours in the neck and other parts, which are commonly slow in ulcerating and in their cure; also in deep-seated scrofulous inflammations, followed by caries of the bones, profuse discharges, and tedious exfoliation, and particularly in scrofulous ophthalmia. "In all such cases, the internal use of sea-water is almost entirely confined to those periods of the disease when there is no general fever and hectic tendency, when no symptoms of danger are present, and when the object is rather to prevent a relapse than oppose any present disease. The external use of sea-water either as a general cold bath, or as a topical application to indolent swellings, or granulating ulcers, when the healing process has commenced, coincides perfectly well in these cases with the general intention." The most important advantages of sea-water are indeed probably derived from its external use as a bath. (See the articles BATH and BATHING.) With respect to the medicinal properties of the bitters, we shall attempt to illustrate them by relating those of the Sedlitz water, which we before selected as an example of the whole tribe. A pint of this water, taken in divided portions, is generally a full dose for an adult, and the strongest person seldom requires more than two pints. It operates very speedily, and without producing griping or flatulency; and is stated by Hoffmann, as quoted by Dr. Saunders, to be of the utmost advantage in a foul state of the stomach, and general torpor of the intestinal canal, as it not only stimulates these organs to expel their morbid contents, but by its bitterness restores their tone, and with it the appetite and digestive powers. "When the presence of hypochondriasis is marked by anxiety, general languor, perturbed dreams, a livid hue on the face, difficulty of breathing, pain of the back and head, vertigo and coldness of the extremities; when a bilious humour and a depraved secretion of the stomach impairs its tone and healthy action, and is attended with obstinate costiveness; this water, by evacuating its contents and restoring the due force of contraction, enables it to throw off the offending matter."—"Numerous trials also have shewn the efficacy of this saline water in that cachexy of females attended with a suppression of the menstrual discharge, whereby

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whereby are produced a general languor, difficult respiration, febrile heat and irritation, wasting of the body, and loss of appetite. Also when women have arrived at that time of life when this periodical evacuation begins to cease, and is succeeded by a number of anomalous disorders, such as prostration of appetite, flatulent pains, irregular flushings, pains in the back and swelling of the feet, a course of Sedlitz water restores the wavering appetite, and disperses the tumours and other morbid symptoms. Men of from forty to fifty years of age, who have led a very sedentary life, and have been accustomed to intense thought and profound meditation, become frequently affected with œdematous tumours in the extremities, a want of due action in the stomach, eructations after taking food, and a generally impaired state of health; all of which are for the most part very certainly removed by a liberal use of this water. Persons also of a plethoric habit of body, who from some obstruction of blood in the abdominal viscera, and have acquired a strong disposition to hæmorrhoidal affections, become thereby often exposed to very serious evils. To such persons a saline water like that of Sedlitz is often of great utility, especially if accompanied by blood-letting when requisite, and a general antiphlogistic plan of cure. Another important use of these waters is in removing from the system those impurities and acrid humours which are usually termed scorbutic." Such are the properties of the Sedlitz saline waters according to the celebrated Hoffmann, whose account, as quoted by Dr. Saunders, we have extracted, because it presents in few words a comprehensive and rational view of the medicinal properties of this important tribe of waters in general. We wish however to observe, that when the stomach is in a very weak state, and dyspepsia is present in a very great degree, saline purgatives and waters in general may do harm by increasing these affections; their use, therefore, in such cases is rather contra-indicated, or at least should be combined with other remedies calculated to invigorate these organs, especially chalybeates.

3. *Simple chalybeate Waters.*—Chalybeate waters are either *simple* or *compound*. Under this head of *simple chalybeates* we include all waters whose characteristic ingredient is one or more of the neutral salts of iron. These may be considered as of two general descriptions:—*a.* Waters containing the carbonate of iron, without any striking excess of carbonic acid; and *b.* Waters containing the sulphate or muriate of iron, generally in combination with a large proportion of the sulphate of alumina. Waters of this last description are much more rare than the former, and are usually formed from the decomposition of iron pyrites.

a. As an example of the first of these varieties of simple chalybeate waters, we may adduce that of Tunbridge Wells. This water has been lately submitted to a careful and accurate analysis by Dr. Scudamore, from whose pamphlet on the subject we chiefly take the following account. The temperature of the spring throughout the year is uniformly 50°; and its sp. gr. in the month of August, at its natural temperature, was 1.0007. The fresh water is perfectly transparent, and does not send forth air-bubbles. It exhales a smell which is distinctly chalybeate. Its taste in this respect is strongly marked, but is neither acidulous nor saline. It has an agreeable freshness, and is by no means unpalatable. Submitted to analysis, one gallon was found to contain,

	Cubic Inches.
Of carbonic acid	8.05
Oxygen	.50
Azote	4.75
	13.30

	Grains.
Of muriate of soda	2.47
———— of lime	.39
———— of magnesia	.29
Sulphate of lime	1.41
Carbonate of lime	.27
Oxyd of iron	2.29
Traces of manganese, insoluble mat- ter (vegetable fibre, silicæ, &c.)	.44
Loss in processes	.13
	7.69

Or, stating the results according to Dr. Murray's view, which will be particularly explained when we treat of the *analysis* of mineral waters, the following estimate will appear:

	Grains.
Muriate of soda	1.25
Sulphate of soda	1.47
Muriate of lime	1.54
———— of magnesia	.29
Carbonate of lime	.27
Oxyd of iron	2.29
Traces of manganese, &c.	.44
Loss, &c.	.13
	7.68

This latter estimate, which renders the carbonate of iron the most abundant ingredient in the water, appears much more probable than the former, and to account more satisfactorily for its medicinal effects.

b. One of the most striking examples of the second variety of simple chalybeate waters is that occurring in the Isle of Wight, and lately analysed by Dr. Marcet. This spring issues from a cliff on the S.S.W. side of the isle, immediately under St. Catherine's Down, in the parish of Chale, between which village and the village of Niton it is nearly equidistant. The distance from the sea-shore is about 150 yards, and elevation about 130 feet above the level of the sea. Its properties, &c. are the following:—When it first issues from the rock it is perfectly transparent, and remains so if kept in close vessels; but when exposed to the air, reddish flakes are soon deposited in it. It has a slight chalybeate smell, and a highly astringent and styptic taste. Its specific gravity, in a course of several experiments, was found to be 1007.5. One pint or sixteen-ounce measures yielded

	Grains.
Of carbonic acid $\frac{1}{3}$ ths of a cubic inch,	
Sulphate of iron, in the state of crystal- lized green sulphate	41.4
Sulphate of alumina, a quantity of which, if brought to the state of crystallized alum, would amount to	31.6
Sulphate of lime dried at 160°	10.1
Sulphate of magnesia crystallized	3.6
Sulphate of soda crystallized	16.0
Muriate of soda crystallized	4.0
Silica	0.7
	107.4

This therefore is the strongest aluminous chalybeate known.

Medicinal Properties and Uses of simple chalybeate Waters.—*a.* The season for drinking the Tunbridge water, which we have selected as an example of the simple carbonated chalybeates,

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lybeates, is usually from May to November. On entering upon the use of this water some aperient should be premised; and Dr. Scudamore recommends that the first dose should be taken at seven or eight o'clock in the morning, the second at noon, and the third about three in the afternoon. The exact quantity to be taken must be varied according to circumstances; but "as a general statement," says Dr. S., "I would say that half a pint daily is the extreme smallest quantity, and that two pints daily is the extreme largest amount to found a just expectation of benefit; and further, in the way of general outline of direction, I conceive that half a pint, a pint, a pint and a half, and two pints, should form the progressive ratio of the total daily quantity to be taken at the three intervals. As the patient arrives at the larger proportions, they may with advantage be subdivided with the interval of a quarter or half an hour, which should be occupied in exercise." Tea at breakfast is directed to be avoided; and in cases when the water disagrees at its natural temperature, it is recommended to be administered warm. "On the first employment of the water, either cold or warm, some inconvenient sensations very commonly arise, such as flushing of the face, slight fulness of the head, with drowsiness and an uneasy distension of the stomach, together with continued flatulence. In general these effects are not of importance, either in degree or duration, and are much to be prevented by previous attention to the stomach and bowels." — "As a general statement, it may be added, that the employment of this water is improper in a very plethoric state of the circulation; also when there is an inflammatory determination to any particular organ, or even when local congestion exists without inflammation. In cases of simple debility of the constitution, the water promises to produce its happiest effects. The proofs of its immediately agreeing with the patient are increased appetite and spirits, and these auspicious symptoms are followed by a gradual improvement in the general energy and strength." The bowels usually become constipated under its use, and require the assistance of medicine. The warm bath is occasionally of service in conjunction with this water, as was long ago pointed out by Hoffmann. Exercise also after its use is generally of great importance. In dyspepsia depending on debility of the stomach, and accompanied with general languor and nervousness, this water is remarkably restorative. In uterine debility also, and chlorosis, its use is often of the utmost service. It has been much recommended likewise in some cutaneous affections. For the

complaints of children, especially when young, (that is to say, under six or seven years of age,) it is not in general adapted, for reasons sufficiently obvious. A course of this water may vary from three weeks to two or three months, according to circumstances. *b.* With respect to the medicinal properties of waters containing the sulphates of iron and alumina, as the Isle of Wight and Hartfell waters above-mentioned, they differ little perhaps, except in degree, from those of the simple chalybeate waters. The Isle of Wight water is so strong, that it is always proper to dilute it at first with twice its quantity of common water; and even then the dose cannot well exceed two or three ounces, which may be gradually increased to about a pint in twenty-four hours. Dr. Saunders recommends the same quantity as the maximum dose of the Hartfell water. Both these waters are often much improved by being gently heated, especially in cases where the stomach is very delicate and irritable. Dr. Lempriere, who has written a pamphlet on the Isle of Wight water, states, that he found it particularly serviceable in the debility induced by the Walcheren fever, chronic dysentery, &c. as well as in every instance when the constitution had been undermined by previous illness, and the ordinary tonics had failed. It is particularly necessary to guard against costiveness during the use of these waters.

Compound Chalybeate Waters.—These may be divided into *a.* Saline chalybeates, and *b.* Acidulous chalybeates.

a. The Cheltenham waters, properly so called, are a good example of the *saline chalybeates*. (For the history of these waters, see CHELTENHAM.) Since that article was written, however, several springs of different qualities and powers have been discovered by Mr. Thomson; an abstract of the composition and properties of which, as lately published, we shall now take the opportunity of laying before our readers.

The springs which have been described and analysed by Messrs. Brande and Parkes are six, *viz.*

1. The strong chalybeate saline water. Sp. gr. 1009.2.
2. The strong sulphuretted saline water. Sp. gr. 1008.5.
3. The weak sulphuretted saline water. Sp. gr. 1006.
4. The pure saline water. Sp. gr. 1010.
5. The sulphuretted and chalybeated magnesia spring, or bitter saline water. Sp. gr. 1008.
6. Saline chalybeate, drawn from the well near the laboratory.

The following Table presents a view of the contents of a wine pint of these different springs.

Springs.	1	2	3	4	5	6
Muriate of soda	41.3	35.0	15.0	50.0	9.5	22.0
Muriate of magnesia	—	—	—	—	9.0	—
Sulphate of soda	22.7	23.5	14.0	15.0	—	10.0
Sulphate of magnesia	6.0	5.0	5.0	11.0	36.5	—
Sulphate of lime	2.5	1.2	1.5	4.5	3.5	—
Carbonate of soda	} 1.5	—	—	—	—	—
Oxyd of iron		0.3	0.5	—	0.5	1.5
Loss	—	—	—	—	1.0	0.5
Total	74.0	65.0	36.0	80.5	60.0	34.0
Sulphuretted hydrogen	—	2.5	2.5	—	1.5	—
Carbonic acid	2.5	1.5	1.5	—	4.0	10.0
Total	2.5	4.0	4.0	0.0	5.5	10.0

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The medicinal properties of these different springs of course vary according to their composition and strength. Mr. Thomson, the proprietor, procures from them six different saline preparations, neither of which, however, is precisely similar to the water drank at the spa. These he denominates, crystallized alkaline sulphates; ditto effloresced and ground to an impalpable powder for hot climates; magnesian sulphate in a state of efflorescence; a murio-sulphate of

magnesia and iron in brown crystals, highly tonic; sub-carbonate of magnesia in powder, and calcined magnesia.

b. As an example of the *acidulous chalybeates*, we may adduce the celebrated waters of Spa. (See SPA.) Dr. Jones has lately published an interesting paper on these waters, which contains, among other things, analyses of the different springs, of the results of which the following table presents a summary view.

TABLE exhibiting the Nature and Proportion of the Substances contained in One Gallon of the respective Spa Waters.

Fountains.	Temperature.	Specific Gravity.	Carbonic Acid Gas. Cub. In.	Solid Contents. Grains.	Sulphate of Soda.	Muriate of Soda.	Carbon. of Soda.	Carbon. of Lime.	Carbon. of Magnesia.	Oxyl of Iron.	Silex.	Alumina.	Loss.
Pouhon	50	1.00098	262.0	26.8	0.92	1.26	2.45	9.87	1.80	5.24	2.26	0.29	2.71
Geronstere	49½	1.0008	168.5	12.50	0.62	0.64	1.43	5.20	1.05	0.94	1.40	0.19	1.03
Sauviniere	49½	1.00075	241.4	8.50	0.05	0.25	0.60	3.50	0.69	2.10	0.40	0.10	0.90
Groesbeeck	49½	1.0007	265.0	5.90	0.05	0.15	0.30	2.40	0.20	1.55	0.60	0.10	0.55
1st Tonnelet	49½	1.00075	282.0	5.30	0.06	0.15	0.20	1.10	0.30	2.70	0.60	0.10	0.09
2d Tonnelet	49½	1.00075	260.5	3.70	*	*	0.10	0.90	0.20	1.50	0.65	*	0.35
Watroz	-	-	not ascertained.	9.30	-	0.2	0.10	1.40	1.90	2.60	0.90	0.60	1.80
The Pouhon, after much wet weather.	-	-	-	32.3	0.80	0.95	2.0	13.82	2.97	4.45	3.27	0.38	3.68

* Quantity not appreciable.

With respect to the medicinal properties of the compound chalybeates, they are, as might be expected, of a mixed character, and usually correspond with the nature of the predominant impregnating ingredients; hence their properties will be readily understood from what has been advanced. For further particulars respecting the medicinal properties of the CHELTENHAM and SPA waters, we refer our readers to these articles.

4. *Simple Acidulous Waters.*—Under this denomination may be included all waters whose characteristic ingredient is an acid. They may be considered as of two descriptions: a. Those impregnated with a volatile acid, as the carbonic and sulphurous acids; and b. Those containing a fixed acid, as the muriatic and sulphuric acids.

a. The waters of Seltzer may be adduced as an example of the first variety of acidulous waters. "Seltzer is a village situated in a fine woody country, about ten miles from Frankfort, and thirty-six from Coblenz, in a district which abounds with valuable mineral springs." This water has been examined by Hoffmann, Bergman, and others. When fresh from the well, it is perfectly clear and pellucid, and sparkles much when poured into a glass. Its taste is slightly pungent, but at the same time gently saline and alkaline. On exposure to the air for a short time, the carbonic acid escapes, and the alkaline taste becomes more per-

ceptible. According to Bergman, an English pint contains of

Carbonic acid upwards of	Cub. Inches.
	17
Carbonate of lime about	Grains.
Carbonate of magnesia	3
Carbonate of soda	5
Muriate of soda	4
	17.5
	29.5

b. Waters containing a free mineral acid in excess are very rare, and chiefly confined to volcanic countries. Mr. Garden has lately examined a water of this description from White island, on the coast of New Zealand: it was of a pale yellowish-green colour; its odour resembled that of a mixture of muriatic and sulphurous acids. Its taste was strongly acid and styptic, like that of a chalybeate. Its specific gravity 1.073. On being submitted to analysis, its contents were found to consist chiefly of muriatic acid, a slight trace of sulphur, small proportions of alum, muriate of iron, and sulphate of lime. Waters impregnated with sulphuric

fulphuric acid are sometimes met with likewise in the vicinity of volcanoes.

As to the *medicinal properties* of these waters, they probably differ little from those of a dilute solution of the different acids which they contain. For the particular properties of the Seltzer water, see SELTZER.

Compound Acidulous Waters.—Acidulous waters sometimes contain so large a proportion of saline matters, that the nature of their operation is considerably modified. Such waters may be denominated *saline acidulous* waters. The nature of their *composition* and *medicinal properties* will be readily understood from what has been already advanced.

5. *Sulphureous Waters.*—These are either *simple* or *compound*. A good example of a *simple* sulphureous water is the Moffat spring. The village of Moffat is situated in Dumfriesshire, on the banks of the Annan, about fifty miles south-west of Edinburgh. The sulphureous waters for which this village is noted, issue from a rock a little below a bog, whence, says Dr. Saunders, they probably derive their sulphureous ingredient. This water, even when first drawn, appears somewhat milky. Its taste is sulphureous, and slightly saline. It sparkles a little when poured from one glass into another. On exposure to the air, it becomes more turbid, and throws up a thin film, which is pure sulphur, and it thus loses its distinguishing properties as a sulphureous spring. This change even takes place in close vessels, so that it cannot be exported with any advantage. According to Dr. Garnett's analysis, a wine pint of this water contains

	Cubic Inches.
Of sulphuretted hydrogen	1.25
Of carbonic acid	.625
Of azote	.5
	<hr style="width: 50px; margin-left: auto; margin-right: 0;"/>
	2.375

And of muriate of soda 4.4 grains.

With respect to the *medicinal properties* of simple sulphureous waters, they have been always celebrated for their good effects in cutaneous affections in general, and also in scrofula. They are applied externally in the form of a warm bath, as well as taken internally. They have been also recommended in bilious complaints, dyspepsia, general want of action in the alimentary canal, and calculous cases. The quantity of the Moffat waters usually prescribed internally varies from one to three bottles every morning. But Dr. Saunders justly observes, that few delicate stomachs can bear so much. On the other hand, the same eminent physician informs us, that the common people not unfrequently swallow from six to ten English quarts in one morning.

For further particulars respecting this spring, see MOFFAT.

Sulphureous waters frequently contain so considerable a proportion of saline substances as to merit the name of *compound*. An example of such waters we have in the celebrated springs of Harrowgate, in Yorkshire. (See HARROWGATE.) This water, when first taken up, appears perfectly clear and transparent. It emits a few air-bubbles. Its smell is very strong, sulphureous, and fœtid, like that of a foul gun-barrel. Its taste is bitter, nauseous, and strongly saline; though it is remarkable that most persons soon become reconciled to it. On exposure to the air, it becomes turbid, the sulphureous odour is diminished, and the sulphur is gradually deposited. According to Dr. Garnett, its spe-

cific gravity is 1.0064. A wine pint, according to the experiments of the same chemist, was found to contain about

	Cubic Inches.
Of sulphuretted hydrogen	2.375
Carbonic acid gas	1.000
Azote	.875
	<hr style="width: 50px; margin-left: auto; margin-right: 0;"/>
	4.25

And of

	Grains.
Muriate of soda	76.9
Muriate of lime	1.6
Muriate of magnesia	11.4
Carbonate of lime	2.3
Carbonate of magnesia	.7
Sulphate of magnesia	1.3
	<hr style="width: 50px; margin-left: auto; margin-right: 0;"/>
	94.2

With respect to the *medicinal properties* of waters of this description, and particularly of Harrowgate water, they are of the greatest use in all those complaints that require purgatives, and at the same time are benefited by sulphur; hence they have been long celebrated in cutaneous affections, in piles, worms, &c. They have also been found of great use in that obstinately costive habit of body which usually accompanies hypochondriasis. Harrowgate waters were formerly principally applied externally, but now they are generally recommended to be taken internally, in such doses as to produce a sensible effect upon the bowels; for which purpose it is commonly necessary to take in the morning three or four glasses, of rather more than half a pint each, at moderate intervals.

6. *Thermal Waters.*—There is something so mysterious and remarkable in the circumstances of thermal springs, that they have in all ages attracted great attention, and been supposed to possess extraordinary medicinal properties. Hence, by most writers on mineral waters, thermal springs have been arranged under a distinct head; and as there appears to be no serious objection to this arrangement, we have thought proper to adopt it. The investigation of the *cause* of thermal springs belongs to the geologist, and will be found under EARTH, HOT SPRINGS, TEMPERATURE, VOLCANO, and analogous articles.

They may be divided into *simple* and *compound*.

Simple thermal waters are either *tepid*, that is, possessing a temperature below that of the human body; or *warm*, possessing a temperature above that point. A good example of the simple tepid waters are those of Buxton. (See BUXTON WATER.) *Tepid* waters usually occur in lime-stone districts. *Warm* waters of every degree of temperature, even to the boiling point, are occasionally met with in the neighbourhood of volcanoes. See VOLCANO.

With respect to the *medicinal properties* of the simple thermal waters, it is extremely doubtful if they possess any other powers than those of common water artificially raised to the same temperature.

Thermal springs are liable to be impregnated with all the different substances which usually enter into the composition of cold mineral waters; hence they are very various in their nature. Such *thermal* waters may be called *compound*, and without any great sacrifice of the principles of arrangement we have adopted, may be comprised under three heads; namely, *a.* Saline thermal waters, *b.* Acidulo-chalybeate thermal waters, and *c.* Sulphureous thermal waters;

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waters; each of which varieties may be either *tepid* or *warm*.

a. Thermal waters simply *saline* are very rare. Their properties can in no respect be supposed to differ from cold saline waters raised to the same temperature. Sea-water, therefore, heated artificially, is a good example of this variety. It is generally used externally as a bath. See BATHING.

b. A good example of the *acidulo-chalybeate* thermal waters we have in the Springs of Carlsbad. For a full account of the chemical properties of these Springs, see CARLSBAD.

c. The celebrated waters of Aix-la-Chapelle, or Aken, afford a good example of the *fulphureous* thermal waters. See AIX-LA-CHAPELLE.

With respect to the *medicinal properties* of the compound thermal waters, they have all been in much repute as baths, which was, perhaps, the original mode in which the two last varieties in particular were employed. In later times, they have been much used internally. The diseases, says Dr. Saunders, to the cure of which the internal use of Carlsbad waters are applicable, are as various as the nature of their foreign contents; and from the union of several valuable qualities in one water, it may be made use of in cases of very opposite natures, without incurring the censure of employing it indiscriminately as an universal medicine. In common with the other purgative chalybeates, it is found to be eminently serviceable in dyspepsia and other derangements of the healthy action of the stomach, in obstructions of the abdominal viscera, not connected with great organic disease, and in defect or deprivation of the biliary secretion. It is also of use in calculous affections, and is highly esteemed for restoring the uterine system to a healthy state. The same precautions against its internal use in plethoric and irritable habits, and those who are subject to hæmoptysis, or liable to apoplexy, require to be observed here as with any of the other active thermal waters. The Aix-la-Chapelle waters, taken internally, are likewise found essentially serviceable in the numerous symptoms of disorders in the stomach and biliary organs, that follow a life of high indulgence in the luxuries of the table. It also much relieves painful affections of the kidneys and bladder. The same precautions in its use are to be attended to, as those above-mentioned respecting the Carlsbad waters. For the external uses of those waters, see BATHING, and the articles CARLSBAD and AIX-LA-CHAPELLE, before referred to.

Our readers will readily perceive, from the above systematic sketch, that the infinite variety which exists among mineral waters absolutely precludes a *perfect* arrangement of them: we trust, however, that no mineral water can occur which may not be referred to one or other of the above heads or their subdivisions, without any great sacrifice of our principles of arrangement; and, consequently, whose general medicinal properties cannot be estimated with tolerable accuracy *à priori* from its chemical composition.

On the general Uses of Water in a dietetic and medicinal Point of View.—No organic process nor interchange of elements can be supposed to take place without the intervention of a fluid; organized beings, therefore, contain a large proportion of fluid in their composition, through the medium of which that endless series of changes, essential to their existence, is principally effected. The basis of this fluid is universally water, which of all other fluids is the most eminently fitted for dissolving and holding in solution every variety of animal and vegetable matter. See FOOD of Plants.

In animals, the first great step in the series of vital processes is *digestion*; and here nature appears to render the pre-

sence of a fluid particularly necessary, in order, as it were, to insure for herself a sufficiency for her future operations. Accordingly, we find that all animals instinctively take in a certain proportion of fluid, either in the form of simple water, or succulent food. Man alone is the only animal accustomed to swallow unnatural drinks, or to abuse those which are natural; and this is the fruitful source of a great variety of his bodily and mental evils.

We know little of the intimate nature of the digestive process, but we know that it is chiefly effected by means of a highly animalized fluid secreted by the stomach itself. Now this important fluid, by drinking too little or too much, or by other causes, may be rendered too concentrated or too dilute for the due performance of its operations; and dyspepsia, and all its consequences, may thus ensue from habitual errors in the quantity of drink only. The remedy in such cases is obvious, and consists perhaps in nothing more than in duly regulating the quantity of watery aliment, as dictated by instinct, or the sensation of thirst only.

An eminent modern physiologist recommends to abstain from drinking during meals, and for some time afterwards; and as a general rule, this may, perhaps, be proper, since a healthy stomach may be supposed to be always able to secrete fluid enough for its own immediate operations: there can be no doubt, however, but many exceptions to this rule may be met with, arising either from the nature of the food or condition of the stomach, in which moderate dilution is not only grateful but salutary.

With respect to the choice of water as an article of diet, (for our readers will understand that we speak of water only in this place,) those which are hard and impure have long lain under the imputation of producing calculous affections; and we have good authority for stating, that, in many instances, the use of such waters actually increases the painful symptoms of these distressing complaints. It is not perhaps an easy task to explain this, since, with the exception of lime, the substances found in hard waters never enter into the composition of calculi: their operation, therefore, must be rather of a predisposing nature, and is probably exerted upon the organs of digestion, which are well known to be intimately connected with the kidney. A fact which renders this opinion the more probable is, that hard waters are often positively noxious to irritable stomachs, by inducing dyspepsia. In short, pure water, as we formerly observed, must obviously be much better adapted for the important purposes of dilution and solution, than water already saturated as it were with foreign substances; and upon this principle may probably be satisfactorily explained the good effects of Malvern and other waters, whose only characteristic property is, their remarkable degree of purity.

In a medicinal point of view, the use of water as a diluent is most important; and, as Dr. Saunders justly observes, the long list of ptisans, decoctions, &c. usually prescribed by physicians in acute diseases, owe their virtues almost entirely to the watery diluent itself.

The instinctive desires or aversions, continues the same eminent writer, of persons labouring under any species of disordered functions, have been justly considered as deserving the highest attention from the physician, and in most cases will furnish him with useful hints for his treatment of the patient. In acute diseases, the thirst after water is peculiarly remarked as a characteristic symptom, and is a direct instinctive indication of increased heat and want of dilution; and this is so uniform, that the degree of fever may often be pretty well estimated by the eagerness of the sufferer after cold drink. The benefits arising from large dilution in acute diseases, however, are not confined to the mere

mere quenching of thirst, though this is in itself highly advantageous; but it is after so much liquid is added to the circulating mass, that the truly diluent effects are produced. These consist, in Dr. S.'s opinion, in diminishing the morbid heat and violence of reaction in the solids; in preserving all the secretory organs in a pervious state; and in checking that tendency to spontaneous change, which renders the fluids positively noxious to the vessels in which they are contained, and unfit to perform those functions, on which the health of the body so essentially depends.

It appears possible, however, in the opinion of the same author, to carry dilution in active fever to excess. In fever, as is well known, the exhalent vessels are comparatively inactive, or morbidly constricted, and the secretion of urine is defective in quantity. In such cases, it is often better to take liquids in small divided doses, which has the effect of moderating the thirst, without overloading the arterial system, and bringing on that tension and plenitude liable to be produced by swallowing too large a proportion of liquids.

In the use of water in acute diseases, the temperature should be particularly attended to. As a general rule it may be laid down, that the temperature of diluents at the different periods of a cold, hot, and sweating stage of a simple febrile paroxysm, should be hot in the first case, cold in the second, and tepid in the third; and it is chiefly in the second stage that the quantity may be most liberal.

Most of the above remarks are equally applicable to the use of water in chronic diseases in general, but more especially in the deranged functions of the stomach and bowels and biliary organs, occasioned by a long and habitual indulgence in high food, strong drink, and all the luxuries of the table, and which are well known to be so decidedly benefited by the use of water as a medicine. As in acute diseases, so in chronic affections likewise, it is often of great importance to attend to the temperature of the water. A draught of cold water, for example, will often induce sickness and other distressing symptoms in delicate dyspeptic habits, while water rendered slightly tepid may be taken with impunity and even advantage. On the other hand, the habitual use of warm water or drinks is to be avoided, and doubtless always does much harm.

We shall close these remarks by a quotation from Dr. Saunders on the habitual use of water. "Water-drinkers," says this eminent writer, "are in general longer lived, are less subject to decay of the faculties, have better teeth, more regular appetites and less acrid evacuations, than those who indulge in a more stimulating diluent for their common drink."

For the *external* uses of water, see the articles BATH and BATHING, where this part of the subject is treated at length.

On the general Contents of Mineral Waters and their Operation.—The proportions of saline and other ingredients in mineral waters are for the most part so small, as apparently to be insufficient for explaining the effects they often produce upon the animal economy. Many attempts, therefore, have been made to explain this circumstance by different writers, and the subject is so interesting, that we cannot let it pass without making a few remarks upon it.

Dr. Saunders, one of the latest and best writers on mineral waters, very properly ridicules the idea of *specific* and other mysterious properties, by which the older authors attempted to explain their operation. This intelligent physician supposes, that a very great proportion of their effects depends solely upon the diluent operation of the water itself. Of this, as we formerly observed, there can be no doubt, in

many instances; and even in all, the mere bulk and temperature of the water must be allowed to produce a certain proportion of the effects. Still, however, innumerable instances occur, in which these are insufficient to explain the whole, even when aided by the additional circumstance of great dilution, on which the above eminent physician likewise lays great stress. The matter, therefore, has always appeared sufficiently puzzling, and it is only lately that a little light has been thrown upon it by the ingenious views of Dr. Murray, which will be more fully explained in the next section.

There can be no doubt that soluble salts in general are capable of exerting a much more powerful effect upon the animal economy, *ceteris paribus*, than those which are insoluble. The muriates are the most soluble class of salts occurring in waters, and are moreover, independently of this, the most active; at least, this is the case with the earthy muriates, especially the muriate of lime. Now this salt, Dr. M. has rendered it probable, exists in all mineral waters found by the usual analytic method to contain the sulphate of lime and muriate of soda, which comprehend by far the greater number. The same ingenious author has also rendered it probable, that iron not unfrequently exists in the state of muriate instead of carbonate, as commonly believed, as for example, in the Bath waters. With these views in general we perfectly coincide, and have no doubt that, in many instances, a large proportion of the good effects of mineral waters arises from the muriates they contain; but we must confess that many difficulties still appear to us to remain on this obscure subject, which cannot, in the present state of our knowledge, be satisfactorily explained.

Analysis of Mineral Waters.—The analysis of mineral waters has been justly deemed one of the most difficult problems in practical chemistry. This arises partly from the diversified nature of the ingredients, and partly from the minute proportions in which some of them exist. The celebrated Bergman was the first chemist who presented the world with a general method or formula for analysing mineral waters. This was esteemed excellent in its day, and even at the present time may be considered valuable. Twenty years afterwards, Mr. Kirwan published an essay on the subject, which not only comprised all that had been previously done, but contained many valuable additions made by himself. He also proposed a new method of analysis, of which we shall give a short account hereafter.

a. The first step in the examination of a mineral water, is to notice accurately its sensible properties, such as its temperature, colour, transparency, taste, smell, &c.

b. The second step is to ascertain its specific gravity, the spontaneous changes it undergoes on exposure to the air, the application of heat, &c.

c. These preliminary operations being performed, the next object of inquiry, is to endeavour to obtain a knowledge of the different ingredients present by means of *reagents*, or *tests*, as they are usually termed. We have already mentioned the different ingredients commonly met with in mineral waters, and shall now proceed to give a list of the different *tests* by which their presence may be detected. For this list we are chiefly indebted to Dr. Thomson, who has compiled it from Kirwan and others.

1. The *Gaseous Substances* may be separated from water, by boiling it in a retort connected with a pneumatic apparatus, and their nature and proportions may be ascertained in the manner to be presently described.

2. *Hydrogen and its Compounds.*—Sulphuretted hydrogen is readily distinguished by its peculiar smell, by its reddening litmus fugaciously, and by its blackening paper dipped in solution

lution of lead. *Carburetted* hydrogen may be detected by its inflammable nature, and by its yielding carbonic acid by combustion. *Phosphuretted* hydrogen may be known by its peculiar smell and spontaneous inflammability.

3. *Atmospheric Air: Oxygen and Azote*.—The presence of oxygen gas may be known by its power of supporting combustion, and by the diminution which takes place on mixing it with nitrous gas or phosphorus. There is no test for azote, but it is sufficiently characterized by its negative properties.

4. *Alkalies and Alkaline Earths*.—The *alkalies* and *alkaline earths*, as well as their *carbonates*, are distinguished in general by the following tests. Turmeric paper is rendered brown by alkalies, or reddish-brown, if the quantity be minute. Brazil wood is rendered blue not only by the alkalies, but also by the alkaline and earthy carbonates. Litmus paper reddened by vinegar is restored to its original colour by alkalies, and also by the alkaline and earthy carbonates. If these changes are fugacious, we may conclude that the alkali is ammonia. *Fixed* alkalies are indicated when a precipitate is produced by muriate of magnesia after being boiled. The *volatile* alkali, or ammonia, may be readily distinguished by its sensible properties. The *earthy* and *metallic* carbonates are precipitated by boiling the water containing them, except carbonate of *magnesia*, which is only precipitated imperfectly. With respect to the individual substances of this class—*Potash* may be distinguished by the precipitate it produces with the muriate of platina, the sulphate of alumina, and tartaric acid. For *soda* there is no good test, but its salts are easily distinguished from those of potash. *Ammonia* may be known from its odour and other properties above-mentioned. *Lime* is detected by means of the oxalic acid, which occasions a white precipitate. To render its operation certain, however, the mineral acids, if present, must be saturated with an alkali. *Magnesia* and *alumina*. Pure ammonia precipitates both these earths and no other, provided the carbonic acid has been previously separated. Lime-water also precipitates only these two earths, provided the carbonic and sulphuric acids be previously removed. The *alumina* may be separated from the *magnesia* by boiling the precipitate in pure potash, which dissolves the alumina and leaves the magnesia. *Silica* may be ascertained by evaporating a portion of the water to dryness, and redissolving the precipitate in muriatic acid. The *silica* remains behind undissolved.

5. *Metals*.—The presence of *metals* may be suspected, if precipitates are produced by the prussiate of potash and sulphuretted hydrogen. *Iron* may be discovered by the following tests. The addition of tincture of nut-galls gives water containing iron a purple or black colour. If the tincture has no effect upon the water after boiling, though it coloured it before, the iron is in a state of carbonate. Prussiate of potash produces a fine blue precipitate in water containing iron, provided no excess of alkali be present, which must be saturated with an acid. *Manganese* is occasionally present in minute quantity, especially in chalybeate waters. It may be precipitated by ammonia with proper precaution, and is known by the beautiful violet hue it imparts to borax, on being fused with that substance. *Copper* is occasionally met with in waters. It may be detected by the fine blue colour produced on the addition of ammonia; by the red-coloured precipitate produced by the prussiate of potash; or it may be obtained in the *metallic* state by plunging into the water a piece of polished iron. *Lead* is sometimes found in waters that have traversed leaden pipes. Such waters are blackened by a current of sulphuretted hydrogen gas; but to render the presence of the metal

more certain, a portion of the water is to be evaporated to dryness; the remainder is to be tested with nitric acid, and afterwards tested with solutions of the carbonate and sulphate of potash, which produce white precipitates, from which the lead may be readily obtained in the metallic state.

6. *Acids*.—*Carbonic acid*, in a free or uncombined state, may be detected by lime-water, which occasions a precipitate soluble with effervescence in muriatic acid; or by the infusion of litmus, which is reddened, but becomes again blue on exposure to the air. Water containing free carbonic acid loses this property of reddening litmus by boiling. The *sulphuric acid* is readily distinguished by the muriate, nitrate, or acetate of barytes, strontian, and lime, and also by the nitrate or acetate of lead. The most delicate of these tests is the muriate of barytes: this produces a white precipitate, insoluble in muriatic acid. To ensure the operation of this test, it is necessary that no earthy or alkaline combination be present in the water. The *muriatic acid* is detected by the nitrate of silver, which occasions a white curdy precipitate, insoluble in nitric acid. To ensure the operation of this test, the alkaline and earthy carbonates must be previously saturated with nitric acid; and the sulphuric acid, if any be present, must be separated by the nitrate of barytes. *Boracic acid* is detected by means of the acetate of lead. The precipitate formed is insoluble in acetic acid. To render this test certain, the alkalies and earths must previously be saturated with acetic acid, and the sulphuric and muriatic acids removed by means of the acetate of strontian and the acetate of silver.

Such is a brief account of the different tests usually employed to detect the ingredients present in mineral waters, and the most obvious precautions to be observed in their use. It is proper, however, to observe, that there are many circumstances to be attended to, in the use of tests in general, which can only be learnt by personal observation and practice, and that the inexperienced chemist is very liable to be misled by them.

d. Having thus acquired, by the employment of tests, a general knowledge of the ingredients contained in a mineral water, the next object is to endeavour to ascertain the quantities and modes of combination in which they exist; and this constitutes by far the most difficult part of the inquiry.

There are two general modes of conducting the analysis of a mineral water: one is to separate, by various appropriate manipulations, the different ingredients in the same compound forms in which they are supposed to actually exist in the water. The other, recommended particularly by Dr. Murray, is to ascertain, chiefly by means of tests, the quantities of the different *simple* substances, and afterwards to *estimate* from them the quantities of the compounds. The first of these modes, and in some instances a combination of both, is the one which has hitherto been generally adopted by chemists; we shall, therefore, give a short account of the manipulations had recourse to for separating a few of the substances most usually occurring in mineral waters.

1. The gaseous matters are first to be separated in the manner formerly mentioned, and their gross amount ascertained by admeasurement in a jar graduated into cubic inches. Sulphuretted hydrogen, if it be present with other gases, is first to be separated by immersing the jar in warm water, and introducing nitric acid, which absorbs the sulphuretted hydrogen, and the diminution of bulk denotes its quantity.

quantity. If sulphurous acid be present, the above step is unnecessary, for sulphuretted hydrogen never exists in water containing this acid. Sulphurous acid may be separated by introducing into the gaseous mixture a quantity of the peroxyd of lead, in a state of powder. This will gradually absorb the whole, and the diminution of bulk, as before, will denote its quantity. The introduction of a little potash, after this, will absorb the carbonic acid. The remaining gases must be oxygen and azote. The oxygen may be separated by introducing a piece of phosphorus, or by other well-known eudiometrical means; and the azote will remain last of all, unaffected by any of these processes.

2. The earthy carbonates, if any be present, are first to be separated by boiling a given portion of the water for a quarter of an hour. The precipitate thus obtained may consist of a mixture of the carbonates of lime, of magnesia, of iron, and of alumina, and even of the sulphate of lime. Supposing all these to be present, the precipitate is to be treated with dilute muriatic acid, which will dissolve the whole, except the alumina and sulphate of lime. Dry this residuum in a red heat, and note the weight. Then boil it in a solution of carbonate of soda; saturate the soda with muriatic acid, and boil the mixture for half an hour: carbonates of lime and alumina will be precipitated; the lime may be then dissolved by acetic acid, while the alumina will remain; and thus the weight of each may be ascertained.

The muriatic solution contains lime, magnesia, and iron. To separate these, add ammonia, which will precipitate the iron and part of the magnesia. Dry the precipitate, and expose it to the air for some time in a temperature of about 200°. The magnesia may be then separated by acetic acid, and the acetate thus formed is to be added to the muriatic solution. The iron is now to be redissolved in muriatic acid, precipitated by an alkaline carbonate, and dried and weighed.

Muriate of lime and magnesia still remain in solution. To separate them, add sulphuric acid as long as any precipitate appears, then heat the solution, and concentrate. The sulphate of lime thus obtained is to be heated to redness, and its weight ascertained. Lastly, the magnesia may be separated by an alkaline carbonate, or, what is much better, by the phosphate of ammonia.

3. To ascertain the quantity of the alkaline carbonates, supposing them to exist in waters, determine how much of any dilute acid, whose strength has been previously carefully ascertained, is necessary to saturate them; and from this the quantity of alkali can be readily estimated.

4. The alkaline and earthy sulphates may be estimated by the following methods.

The alkaline sulphates may be determined by precipitating their acid by means of the nitrate of barytes, having previously separated all the earthy sulphates.

Sulphate of lime is readily estimated by evaporating the water to a few ounces, the earthy carbonates being previously saturated with nitric acid, and precipitating the sulphate of lime by means of dilute alcohol.

If the sulphate of magnesia or alumina be the only sulphate present, the quantity of either can be readily estimated. If they exist together, the two earths may be precipitated by soda, and afterwards separated by acetic acid in the manner above-mentioned. If sulphate of lime be also present, this may be previously separated in a great degree, as above; or, what is preferable, the lime may be precipitated by an alkali along with the other earths, and afterwards separated. The same holds good also with the sulphate of iron; or the iron may be separated by exposing the water

for some days to the air, and mixing with it a portion of alumina. The oxyd of iron and sulphate of alumina are precipitated together, and may be easily separated, and the quantity of iron ascertained.

5. If muriate of potash or soda exist alone in water, its quantity can be readily estimated by precipitating the muriatic acid with the nitrate of silver. The same process may be followed, if the alkaline carbonates be present; only these carbonates must be previously saturated with sulphuric acid, and, instead of using the nitrate, the sulphate of silver is to be employed.

If the alkaline muriates exist along with more or less of the earthy muriates, or with the muriate of iron, without any other salts, the whole of the earths may be separated by barytes water, and their quantities estimated as before. To discover the proportion of the alkaline muriates, the barytes is to be separated by sulphuric acid, and the muriatic acid expelled by heat. The quantity of the alkaline muriates may be then ascertained by evaporation.

When sulphates and muriates exist together, they may be separated by evaporating the whole to dryness, and dissolving the earthy muriates in alcohol; or, when the water has been duly concentrated, by precipitating the sulphates with the same fluid.

When alkaline and earthy muriates exist with sulphate of lime, this last salt is to be decomposed by means of the muriate of barytes. The estimation is then to be conducted as if nothing but muriates are present, only the proportion of muriatic acid which united in the muriate of barytes, added, must be allowed for.

When muriates of soda, magnesia, and alumina, are present, together with sulphates of lime and magnesia, the water is better examined by two distinct operations. To one portion add carbonate of magnesia, till the whole of the lime and alumina be precipitated. Ascertain the quantity of lime, which gives the proportion of sulphate of lime. Precipitate the sulphuric acid by muriate of barytes: this gives the quantity contained in the sulphate of magnesia and sulphate of lime; and the quantity of sulphate of lime being previously known, that of the sulphate of magnesia can be easily estimated. To a second portion of the water add lime-water, till the whole of the magnesia and alumina be separated. From the weight of these earths the quantity of their muriates may be estimated, that portion of the magnesia previously found to be in union with sulphuric acid being deducted. After this, remove the sulphuric acid by barytes water, and the lime by carbonic acid, and the liquid evaporated to dryness will leave the common salt.

6. Lastly: If the fixed mineral acids should alone be found to exist in a water, it need scarcely be observed that their quantities can be readily ascertained; the sulphuric acid by means of a barytic salt, and the muriatic acid by means of a salt of silver.

All these different precipitates should be dried uniformly, or at least at some known degree of temperature. It is not easy to fix this point, which must in a great degree be regulated by the nature of the salt, and the peculiar views of the analyst; some choosing to reduce the salts to an anhydrous, others to a crystallized state. As a sort of check also to the analysis, it is proper to evaporate a known quantity of the water to dryness, in order to learn the gross amount of the saline matters it contains, which amount is to be compared with the results as obtained by the different processes of the analysis.

Such are a few of the most common methods recommended for separating and ascertaining the proportions of the

different saline substances contained in a mineral water. They must of course be varied according to circumstances; but this, as well as the application of other methods, must depend upon the practical knowledge and judgment of the analyst.

The principles, however, upon which many of the above analytical processes are founded, have been lately called in question by Dr. Murray of Edinburgh, and we think very justly. That gentleman has endeavoured to shew, that we by no means arrive at a just knowledge of the constituents of a mineral water by these processes, and that many of the compounds obtained by them are determined by the processes themselves. The following quotation, from a paper by Dr. Murray, entitled "A general Formula for the Analysis of Mineral Waters," in the eighth volume of the Transactions of the Royal Society of Edinburgh, will convey a distinct idea of his opinions and mode of reasoning upon the subject.

Two methods of analysis have been employed for discovering the composition of mineral waters, what may be called the *direct* method, in which, by evaporation, aided by the subsequent application of solvents, or sometimes by precipitants, certain compound salts are obtained; and what may be called the *indirect* method, in which, by the use of reagents, the principles of these salts, and bases of which they are formed, are discovered, and their quantities estimated, whence the particular salts and their proportions may be inferred.

Chemists have always considered the former of these methods as affording the most certain and essential information. They have not neglected the latter, but they have usually employed it as subordinate to the other. The salts produced by evaporation have been uniformly considered as the real ingredients; and nothing more was required, therefore, it was imagined, for the accuracy of the analysis, than the obtaining them pure, and estimating their quantities with precision. On the contrary, in obtaining the elements merely, no information, it was believed, was gained with regard to the real composition; for it still remained to be determined in what mode they were combined: and this, it was supposed, could be inferred only from the compounds actually obtained. This method, therefore, when employed with a view to estimate quantities, has been had recourse to only to obviate particular difficulties attending the execution of the other, or to give greater accuracy to the proportions, or, at furthest, when the composition is very simple, consulting chiefly of one genus of salts.

Another circumstance contributed to lead to a preference of the *direct* mode of analysis,—the uncertainty attending the determination of the proportions of the elements of the compound salts. This uncertainty was such, that even from the most exact determination of the absolute quantities of the acids and bases existing in a mineral water, it would have been difficult, or nearly impracticable, to assign the precise composition and the real proportions of the compound salts: and hence the necessity of employing the *direct* method of obtaining them.

The present state of the science leads to other views.

If the conclusion was just, that the salts obtained by evaporation, or any analogous process from a mineral water, are its real ingredients, no doubt could remain of the superiority of the *direct* method of analysis, and even of the absolute necessity of employing it. But no illustrations, I believe, are required to prove that this conclusion is not necessarily true. The concentration by the evaporation must, in many cases, change the state of combination; and the salts obtained are hence frequently products of the operation, not

original ingredients. Whether they are so or not, and what the real composition is, are to be determined on other grounds than on their being actually obtained; and no more information is gained, therefore, with regard to that composition, by their being procured, than by their elements being discovered; for when these are known, and their quantities are determined, we can, according to the principle from which the actual modes of combination are inferred, whatever this may be, assign with equal facility the quantities of the binary compounds they form.

The accuracy with which the proportions of the constituent principles of the greater number of the compound salts are now determined, enables us also to do this with as much precision as by obtaining the compounds themselves; and if any error should exist in the estimation of their proportions, the prosecution of these researches could not fail soon to discover it.

The mode of determining the composition of a mineral water, by discovering the acids and bases which it contains, admits in general of greater facility of execution, and more accuracy, than the mode of determining by obtaining insulated the compound salts. Nothing is more difficult than to effect the entire separation of salts by crystallization, aided even by the usual methods of the action of alcohol, either as a solvent or a precipitant, or by the action of water as a solvent at different temperatures: in many cases, it cannot be completely attained, and the analysis must be deficient in accuracy. No such difficulty is attached to the other method. The principles being discovered, and their quantities estimated in general from their precipitation in insoluble compounds, their entire separation is easily effected. Nothing is easier, for example, than to estimate the total quantity of sulphuric acid by precipitation by barytes, or of lime by precipitation with oxalic acid; and this method has one peculiar advantage with regard to accuracy, that if any error is committed in the estimation of any of the principles, it is discovered in the subsequent step of inferring the binary combinations: since, if all the elements do not bear that due proportion to each other, which is necessary to produce the state of neutralization, the excess or deficiency becomes apparent, and of course the error is detected. The *indirect* method, then, has every advantage over the other, both in accuracy and facility of execution.

Another advantage is derived from these views, if they are just, that of precluding the discussion of questions, which otherwise fall to be considered, and which must often be of difficult determination, if they are even capable of being determined. From the state of combination being liable to be influenced by evaporation, or any other analytic operation, by which the salts existing in a mineral water are attempted to be procured, discordant results will often be obtained, according to the methods employed: the proportions at least will be different, and sometimes even products will be found by one method, which are not by another. In a water which is of a complicated composition, this will more peculiarly be the case. The Cheltenham waters, for example, have in different analyses afforded results considerably different: and on the supposition of the salts procured being the real ingredients, this diversity must be ascribed to inaccuracy; and ample room for discussion with regard to this is introduced. In like manner, it has often been a subject of controversy whether sea-water contains sulphate of soda with sulphate of magnesia. All such discussions, however, are superfluous. The salts procured are not necessarily the real ingredients, but in part, at least, are products of the operation; liable, therefore, to be obtained or not, or to be obtained in different proportions, according to the

method employed: and all that can be done with precision is to estimate the elements, and then to exhibit their binary combinations, according to whatever may be the most probable view of the real composition.

The method proposed by Mr. Kirwan, formerly alluded to, consists in determining, chiefly by tests, the quantity of the different saline substances present. But the complicated nature of many of the formulæ, beside the very principle of the method itself, being liable to most of the objections above urged by Dr. Murray against that in common use, render its application difficult, and results uncertain. Upon the whole, therefore, we have no hesitation in saying, that we consider Dr. Murray's views and methods as by far the best, and most likely to lead to correct conclusions, that have yet appeared, and which may be stated in few words, as follows:

“Determine by precipitants the weight of the acids and bases present in a mineral water. Suppose them united in such a manner that they shall form the most soluble salts: these salts will constitute the true saline constituents of the water under examination.”

Dr. Murray illustrates his method of procedure by supposing, as an example, a water found, by the usual tests, to contain the carbonates, sulphates, and muriates of lime, magnesia, and soda. The water is to be reduced by evaporation as far as can be done, without occasioning any sensible precipitation or crystallization. A saturated solution of muriate of barytes is then directed to be added as long as any precipitate falls, and no longer. This precipitates the whole of the sulphuric and carbonic acids, and the carbonate of barytes is to be separated from the sulphate by diluted muriatic acid. Add to the residual liquor a solution of oxalate of ammonia as long as any turbid appearance is produced. By this the whole of the lime is separated. The oxalate of lime is to be calcined, and converted into sulphate of lime, from which the quantity of pure lime may be readily estimated. The next step is to precipitate the magnesia; and for this purpose, Dr. Murray recommends a modification of Dr. Wollaston's process. This consists in adding, first, a solution of neutral carbonate of ammonia, and afterwards a strong solution of phosphoric acid, or phosphate of ammonia; taking care to leave an excess of the carbonate of ammonia. By these processes, the whole of the magnesia is obtained in the state of triple phosphate, and its quantity can be readily estimated. Muriate of soda now remains in solution, and its quantity can be obtained by evaporation. As a check, however, to the different processes, it may be proper to ascertain the quantity of muriatic acid present by means of the nitrate of silver.

If alumina, silica, or iron be present, they are best separated by distinct processes, in the manner formerly described.

Lastly, Dr. Murray recommends that the results of an analysis be stated in three modes: 1st, The quantities of the acids and bases; 2dly, The quantities of the binary compounds, as inferred from the principle that the most soluble compounds are the ingredients; and 3dly, The quantities of the binary compounds, such as they are obtained by the usual modes of analysis. The results will be thus presented in every point of view. As an instance of this method of stating the results of an analysis, we refer our readers to what we have said on *sea-water* in the present article.

Mineral Waters, artificial Preparation of.—Chemistry had no sooner developed the composition of mineral waters, than it suggested methods of preparing them artificially. Accordingly, Bergman and others have given many formulæ for

this purpose, some of which approach the truth, while others are very imperfect. When the composition of a water is very simple, nothing more is required to form it artificially than to know the nature and quantity of the saline substances present, and to dissolve similar quantities of the same saline substances in the same proportion of water. In the earlier periods of chemical investigation, before the nature of gaseous substances was understood, no attempts of course could be made to imitate the important class of waters which derive their chief properties from the presence of such substances; but chemists no sooner became acquainted with the nature of gases, than they began to devise methods of imitating these also; and artificial carbonated waters have been long since prepared as an article of commerce, under the name of *soda water*, superior in point of impregnation to any acidulous waters known. See *Pyrmont*.

It is true that there are some instances of natural chemical solution, which art has not even yet been able to imitate. Of this kind is the solution of silex, which occasionally occurs in mineral waters. It is doubtful, however, if this earth is capable of exerting any salutary effects on the animal economy; and, therefore, we have little occasion perhaps to regret our inability to effect its solution. Another defect in the formation of artificial mineral waters is, that many of the more important ones cannot be obtained in large quantities for bathing, &c. without so great a degree of expence and trouble, as to entirely preclude their use.

On the other hand it seems plausible, in theory at least, that we can improve upon the composition of many mineral waters. Thus, many mineral waters contain ingredients, which, either from the minuteness of the proportion in which they exist, or from their inert nature, may be deemed as superfluous, or in some instances as injurious. Again, others contain their active ingredient in such small quantities, as to require an inconvenient bulk of the water to produce the desired effect: all which defects may be remedied in the artificial preparation, by leaving out the useless or noxious matter, and increasing that in which the proper medicinal virtue resides. Besides these advantages also, we have it in our power to form new and valuable compounds, which are no where to be met with in a natural state.

The first step to the artificial formation of a mineral water is, of course, to know the exact composition of the water we would imitate. Many of the ingredients, however, obtained from mineral waters by the usual modes of analysis, are very little soluble in water: such, for example, are the sulphate and carbonate of lime, &c. which we should attempt in vain to dissolve directly in water. Other modes, therefore, must be devised for this purpose; and Dr. Murray's views of the composition of mineral waters in general will enable us to effect our object, in most instances, very readily and completely, as the following example will shew.

Suppose we wished to imitate the Seltzer water, an English pint of which, according to Bergman's analysis, contains, as before mentioned, of

	Cub. Inches.
Carbonic acid - - - -	17
	Grains.
Carbonate of lime - - -	3
Carbonate of magnesia - -	5
Carbonate of soda - - -	4
Muriate of soda - - - -	17.5
	29.5

WATER.

Of these ingredients, neither the carbonate of lime nor magnesia are soluble in water, nor can be rendered so, without a tedious process of impregnating the water, through which they are diffused, with carbonic acid gas. But if we adopt Dr. Murray's views, and consider a pint of this water as actually containing of

	Cub. Inches.
Carbonic acid gas	17
	—
	Grains.
Muriate of lime -	3.3
Muriate of magnesia	5
Muriate of soda -	7.8
Carbonate of soda	10.3 dry, or 18 crystallized.
	—
	26.4
	—

we can easily imitate its composition in the following manner :

About 35 grains of muriatic acid, of the strength usually met with in the shops, are to be put into a strong bottle, with a pint of water, the acid being introduced to the bottom of the water by a long funnel. Three grains of pure white marble in coarse powder are then to be dropped in, and the bottle closed. When these are dissolved, five grains of the common carbonate of magnesia in powder are to be added ; and after the solution of this, 32 grains of crystallized carbonate of soda, or what is equivalent to this, and preferable, as affording more carbonic acid, 27 grains of bicarbonate of soda, are to be put in. The bottle is to be closed accurately, shaken, and inverted. In a short time a perfect solution takes place, and a liquor is obtained transparent, which sparkles when poured out, has a pleasant taste, and in its composition resembles the Seltzer water.

It might be supposed, says Dr. Murray, that so large a proportion of carbonate of soda could not exist with the muriates of magnesia and lime, without decomposing them ; but on making the experiment, it was found that the above quantities might be dissolved in a pint of water, independently of the excess of carbonic acid, without any apparent decomposition ; the solution remaining transparent, even on exposure to the air.

Upon similar principles may the composition of almost every other mineral water be readily imitated.

We have an agreeable imitation of acidulous waters, under the term of what is called the *effervescent draught*. This consists of two solutions, one of an alkaline carbonate, and the other of the citric or some other vegetable acid, which are directed to be mixed together, and swallowed during the act of effervescence. A more portable form of this grateful draught is to be obtained in the shops, under the name of *Sodaic powders*, *Seidletz powders*, &c. in which the requisite proportions of alkali and acid in their dry state are formed into separate little packets, one of each of which is directed to be dissolved separately in water, and the two solutions to be then mixed, and swallowed during the act of effervescence, as before.

The following, therefore, may be laid down as a general rule for the artificial preparation of mineral waters :—Ascertain, upon Dr. Murray's principles, the precise proportions of the *most soluble* salts that can be present in any given water ; dissolve similar proportions of the same salts in an equal quantity of water, and a compound water will be obtained, precisely similar in its composition to the original.

Catalogue of the most important mineral Waters.—The following catalogue is intended to comprise the principal mineral waters of Great Britain, and some of the more important ones of other countries. Our readers will recollect that, in the preceding article, we divided natural waters into *potable, saline, chalybeate, acidulous, sulphureous*, and *thermal*, and described the general chemical and medicinal properties of each class, as well as of their compounds. To prevent repetition, and to save room, therefore, we have attempted to refer the different springs, mentioned in the following catalogue, to one or other of the above classes : thus, when a spring is stated to be *saline*, its general composition and properties are to be understood to resemble the class of *saline* waters ; and so of the rest.

The moderns have very properly exploded the old notion of the mysterious and *specific* operation of particular springs. But even if this cogent reason for generalization did not exist, it would be impossible, in a work of the present description, to descend to all the minutæ of analysis, &c. supposing them to be known, which is far from being the case : we have thought proper, however, to give a few of the more interesting and instructive recent analyses of some of the most important springs.

Those springs marked thus *, in the following list, are more particularly described in the preceding article, as examples of the different classes.

Abcourt. An acidulous chalybeate spring. See **AB-COURT**.

Aberbrothick, or Arbroath. An acidulous chalybeate spring. See **ABERBROTHICK**.

Acton. A saline spring. See **ACTON**.

Aghaloo, Tyrone, Ireland. A sulphureous spring slightly saline.

* *Aix-la-Chapelle.* Sulphureous thermal springs. See **AIX-LA-CHAPELLE**.

Alford. A saline spring. See **ALFORD**.

Alkerton, near Gloucester. A saline spring.

Anaduff, Leitrim. A weak sulphureous spring slightly saline.

Ashwood, Fermanagh. A sulphureous spring slightly saline.

Asheron, Yorkshire. A strong sulphureous spring slightly saline.

Astrop, Oxfordshire. An acidulous chalybeate spring.

Astwarby, Lincolnshire. A saline chalybeate spring.

Athlone, Westmeath. A chalybeate spring slightly saline.

d'Ax-en-foix, France. Sulphureous thermal springs, in repute as baths.

Baden. Sulphureous springs, formerly in much repute as baths. See **BADEN**.

Bagnigge-Wells. Two springs, one saline, the other chalybeate. See **PANCRA**S.

Baix. Thermal springs, in much repute among the Romans. See **BALÆ**.

Balaruc. Saline thermal springs. See **BALARUC**.

Ballycastle. Two chalybeate springs, one in which the iron is in combination with carbonic acid, the other with sulphuric acid. See **BALLYCASTLE**.

Ballynabinch, Downshire. A sulphureous spring, said to contain iron.

Bagnères, France. Thermal springs, in much repute as baths. See **BAGNERES**.

Balfon, North America. A highly acidulous chalybeate spring. According to the recent analysis of a French chemist, 25 fluid ounces contain of

WATER.

	Cub. Inches.
Carbonic acid - - - -	75
	Grains.
Muriate of soda - - -	31
Carbonate of lime - - -	22
Muriate of magnesia - - -	12.5
Muriate of lime - - -	5
Carbonate of iron - - -	4
	74.5

is about 74°. A wine pint, according to Dr. Carrick's analysis, contains of

	Cub. Inches.
Carbonic acid gas - - -	3.75
Common air - - - -	0.375
	4.125
	Grains.
Muriate of magnesia - - -	0.9
Muriate of soda - - -	0.5
Sulphate of soda - - -	1.4
Sulphate of lime - - -	1.47
Carbonate of lime - - -	1.63
	5.9

Barege. Sulphureous thermal springs, in considerable repute. See BAREGE.

Barnet, Hertfordshire. A weak saline spring. At North-hall, about three miles from Barnet, is another of the same description, but a little stronger.

Bath. Celebrated saline thermal springs, containing likewise a little iron. (See BATH.) One of the most recent and probably correct analyses of these waters is by Mr. Phillips. According to this gentleman, a wine pint contains of

	Cub. Inches.
Carbonic acid - - - -	1.2
	Grains.
Sulphate of lime - - -	9
Muriate of soda - - -	3.3
Sulphate of soda - - -	1.5
Carbonate of lime - - -	0.8
Silex - - - -	0.2
Oxyd of iron - - - -	0.0147
	14.8147

Bilton, Yorkshire. A weak saline sulphureous spring.

Binley, Warwickshire. A saline chalybeate spring.

Borrowdale, Cumberland. A strong saline water. See BORROWDALE.

Borset. Sulphureous thermal springs, in considerable repute. See BORSET.

Brabach, Germany. An acidulous chalybeate spring.

Brandola, Italy. A weak acidulous chalybeate spring.

Brentwood, Essex. A saline spring.

Brighton. A chalybeate spring: sulphate of iron. (See BRIGHTHELMSTON.) According to Dr. Marcet's analysis, a wine pint contains of

	Cub. Inches.
Carbonic acid gas - - -	2.5
	Grains.
Sulphate of iron - - -	1.80
Sulphate of lime - - -	4.09
Muriate of soda - - -	1.53
Muriate of magnesia - - -	0.75
Silex - - - -	0.14
Lofs - - - -	0.19
	8.50

Bristol Hotwells. A simple thermal water. As this spring has not been described in its proper place, we shall insert the following short account of it here. This water is inodorous, perfectly limpid and sparkling, and sends forth air-bubbles when poured into a glass. It is agreeable to the palate, but has no decided taste. Its specific gravity is stated to be 1.00077. Its temperature, upon an average,

It was formerly much celebrated in consumption, but its supposed good effects in this disease have been justly called in question by modern writers.

Bromley, Kent. A chalybeate spring. See BROMLEY.

Broughton, Yorkshire. A strong saline sulphureous spring, similar to that of Harrogate.

Buch, near Carlsbad, in Bohemia. A weak acidulous water.

Buglawton, Cheshire. A saline sulphureous water.

Burlington, or *Briddlington*, Yorkshire. A chalybeate water slightly saline.

Burnley, Lancashire. A chalybeate water slightly saline.

**Buxton*. A simple thermal water. See BUXTON-WATER.

Cannock, Staffordshire. A chalybeate water.

Cargyrle, near Chester. A weak saline water.

Carlsbad. Celebrated acidulo-chalybeate thermal springs. See CARLSBAD.

Carlton, Nottingham. A chalybeate water.

Castleconnel. A chalybeate water. See CASTLECONNEL.

Castlemain. A sulphureous spring said to contain iron. See CASTLEMALIN.

Cawley, Derbyshire. A sulphureous water slightly saline.

Cawthorpe, Lincolnshire. A chalybeate spring slightly saline.

Cheddington, Oxfordshire. A sulphureous water slightly saline.

Chaud Fontaine, near Liege, Germany. Thermal springs celebrated as baths.

**Cheltenham*. Saline and saline chalybeate springs. See CHELTENHAM.

Chippenham, Wiltshire. A chalybeate spring.

Cleves. An acidulous chalybeate spring. See CLEVES.

Clifton, Oxfordshire. A saline spring.

Cobham, Surry. A chalybeate water.

Codsal Wood, Staffordshire. A sulphureous spring.

Colchester, Essex. A saline spring.

Colurian, Cornwall. A chalybeate spring.

Comner, or *Cummer*, Berkshire. A weak saline spring.

Corstorphine, near Edinburgh. A weak sulphureous spring slightly saline.

Coventry. A saline chalybeate spring. See COVENTRY.

Crickle Spa, Lancashire. A strong saline sulphureous water.

Croft, Yorkshire. A sulphureous water slightly saline.

Croft town, Waterford. A sulphureous spring.

Cunley-house, Lancashire. A strong sulphureous spring slightly saline.

Deddington. Saline sulphureous springs. See DEDDINGTON.

Derby. A chalybeate spring.

Derrindaff,

WATER.

Derrindaff, Cavan. A sulphureous spring slightly saline.
Derry-hinch, Fermanagh. A sulphureous spring.
Dog and Duck, St. George's Fields, Southwark. A saline spring.
Drig-well, Cumberland. An acidulous chalybeate spring.
Drumafnave, Leitrim. A strong sulphureous spring slightly saline.

Dublin. Several weak saline springs.
Dulwich, Kent. Pretty strong saline spring.
Dunblane, Perthshire. These springs have been only lately discovered. They have been accurately analysed by Dr. Murray. There are two springs, both of a similar nature, that is to say, saline, with a minute proportion of iron. A wine pint of the *north spring* was found by Dr. M. to contain of

	Grains.
Muriate of soda - - -	24.3
Muriate of lime - - -	18.
Sulphate of lime - - -	3.1
Carbonate of lime with a trace of iron -	0.5
	45.9

The same quantity of the *south spring* yielded

	Grains.
Muriate of soda - - -	22.5
Muriate of lime - - -	16.
Sulphate of lime - - -	2.3
Carbonate of lime - - -	0.3
Oxyd of iron - - -	.15
	41.25

Dunse, Scotland. A chalybeate spring.
Durham. A strong sulphureous water slightly saline.
Egra, Bohemia. A celebrated saline chalybeate spring.
 See EGRA.

Epsom. A celebrated saline spring. See EPSOM.
Felstead, Essex. A chalybeate spring.
Filab, Yorkshire. A saline chalybeate spring.
Francfort on the Maine. Saline sulphureous springs.
 See FRANCFORT.

Galway, Ireland. A chalybeate spring.
Geyser, Iceland. Remarkable thermal springs. See ICELAND.

Glanmille, Ireland. A chalybeate spring.
Glastonbury. A chalybeate spring slightly saline. See GLASTONBURY.

Glendy, Angusshire. A strong chalybeate spring.
Gransbarow, Downshire. A chalybeate spring.
Haigh, Lancashire. A chalybeate spring: sulphate of iron.
Hampstead. A chalybeate water. See HAMPSTEAD. The most recent analysis of this water is by Mr. Blifs, according to whom a wine gallon contains of

	Cub. Inches.
Carbonic acid - - -	10.1
Atmospheric air - - -	90.9
	101.
	Grains.
Oxyd of iron - - -	1.5
Muriate of magnesia - - -	1.75
Sulphate of lime - - -	2.12
Muriate of soda nearly - - -	1.0
Of flex about - - -	.38
	6.75

Hanbridge, Lancashire. A chalybeate water slightly saline.

Hanlys, Shropshire. Two springs, one saline the other chalybeate.

**Harrogate*. Saline sulphureous springs. See HARROGATE.

Hartfell, Annandale. A chalybeate spring: sulphate of iron. According to Dr. Garnett's analysis, a wine pint of this water contains of

	Grains.
Sulphate of iron - - -	10.5
Sulphate of alumina - - -	1.5
Oxyd of iron - - -	1.875
	13.875

Hartlepool. A chalybeate spring. See HARTLEPOOL.

Holt, Wiltshire. A weak saline water.

Holt-nevil, Leicestershire. A chalybeate spring: sulphate of iron. See HOLT Waters.

Jeffop's Well, near Cobham, Surry. A strong saline water slightly chalybeate.

Ilmington, Warwickshire. A chalybeate spring.

Inglewhite, Lancashire. A strong chalybeate spring.

Isle of Wight. A very strong chalybeate: sulphate of iron.

Islington. A chalybeate spring. See ISLINGTON.

Kanturk, Cork. A chalybeate spring.

Katrine Loch, Scotland. On the north side of this lake is a strong chalybeate spring.

Keddleston, Derbyshire. A strong sulphureous water moderately saline.

Kensington. A saline spring. See KENSINGTON.

Kilbreaw, Meath. A chalybeate water: sulphate of iron.

Kilburn, Middlesex. A saline spring.

Kilroot, Antrim. A saline spring.

Kiling-shanvally, Fermanagh. A chalybeate water slightly saline.

Killashber, Fermanagh. A strong sulphureous water.

Kinalton, or *Kynolten*, Nottinghamshire. A weak saline water.

Kincardine. A chalybeate spring.

King's-cliff, Northamptonshire. A chalybeate spring weakly saline.

Kirby or *Kirkby-thower*, Westmoreland. Two chalybeate springs.

Knareborough, the *Dropping-well*, contains lime held in solution by carbonic acid. See KNARESBOROUGH.

Knowsley, Lancashire. A chalybeate spring.

Korytna, Moravia. A very strong sulphureous spring.

Kuka, Bohemia. A chalybeate acidulous water.

Lancaster. A chalybeate spring slightly saline.

Latham, Lancashire. A chalybeate spring.

Leuk, Valois, Switzerland. Thermal springs.

Llandrindod, Radnorshire. Three springs; one saline, another sulphureous, and the third chalybeate.

Llangybi, Carnarvonshire. A saline spring.

Leamington. A saline spring. See WARWICK.

Leez, Essex. A chalybeate spring.

Lincomb, Bath. A chalybeate spring slightly saline.

Lisbeak, Fermanagh. Two sulphureous springs.

Lis-done-varna, Clare. A strong chalybeate water.

Loanbury, Yorkshire. A sulphureous spring slightly saline.

Maccroom, near Cork. A chalybeate spring.

Mahercberg, Kerry. A saline spring.

Mallow,

Mallow, Cork. A pure thermal spring. See MALLOW.
Malton, Yorkshire. A strong chalybeate spring moderately saline.

**Malvern*, Worcestershire. Very pure springs. See MALVERN. One wine gallon of the Malvern Holywell waters, according to Dr. Wilson, contains of

	Grains.
Carbonate of soda	5.33
Carbonate of lime	1.6
Carbonate of magnesia	.919
Carbonate of iron	.625
Sulphate of soda	2.896
Muriate of soda	1.553
Residuum, filix	1.687
	14.610

According to the same chemist, one gallon of the Malvern St. Ann's well contains of

	Grains.
Carbonate of soda	3.55
Carbonate of lime	.352
Carbonate of magnesia	.26
Carbonate of iron	.328
Sulphate of soda	1.48
Muriate of soda	.955
Residuum, filix	.47
	7.395

Markshall, Essex. A chalybeate water.

Matlock, Derbyshire. Thermal springs, temp. about 66°. See MATLOCK.

Maudsley, Lancashire. A sulphureous water moderately saline.

Mechan, Fermanagh. Two sulphureous springs.

Millar's Spa. A chalybeate spring.

**Moffat*, Annandale. Two sulphureous springs. See MOFFAT.

Mossbouse, Lancashire. A chalybeate spring.

Moreton, Shropshire. A saline spring.

Mont d'Or, near Clermont, France. Sulphureous thermal springs.

Mount Pallas, Cavan. A chalybeate spring.

Nevil Holt. See HOLT.

Newnham Regis, Warwickshire. Three chalybeate springs slightly saline.

Newton Dale, Yorkshire. An acidulous water holding lime in solution.

Newton Stewart, Tyrone. A chalybeate spring.

Neuzenice, Germany. An acidulous water.

Nobber, Meath. A chalybeate spring: sulphate of iron.

Normanby, Yorkshire. A sulphureous spring slightly saline.

Nottingham, Dorsetshire. A strong sulphureous water.

Orfson, Nottingham. A chalybeate spring.

Oulton, Norfolk. A weak chalybeate spring.

Oswen Breun, Cavan. A sulphureous spring slightly saline.

Pancras, Middlesex. A saline spring.

Passy, near Paris. A moderately strong chalybeate spring.

Peterhead, Aberdeenshire. A strong chalybeate spring. See PETERHEAD.

Pettygoe, Donegal. A strong sulphureous water, saline.

Pitcaithly, Perthshire. These springs resemble closely those of *Dunblane*, and have been lately analysed by Dr. Murray, according to whom a wine pint contains of

	Cubic Inches.
Atmospheric air	0.5
Carbonic acid gas	1.
	1.5
	Grains.
Muriate of soda	13.4
Muriate of lime	19.5
Sulphate of lime	.9
Carbonate of lime	.5
	34.3

Plombiers, France. A thermal spring.

Pontgibault, France. A weak acidulous spring.

Pyrmont, Westphalia. A highly acidulous chalybeate spring. See PYRMONT.

Queen's Camel, Somersetshire. A sulphureous spring.

Richmond, Surry. A saline spring.

Road, Wiltshire. A chalybeate spring.

Rougham, Lancashire. A saline spring.

St. Bartholomew's Well, Cork. A chalybeate water slightly saline.

St. Bernard's Well, Edinburgh. A sulphureous water slightly saline.

St. Erasmus's Well, Staffordshire. A weak saline water.

St. Winifrid's Well, Flint. A very pure spring. See HOLYWELL.

Scarborough, Yorkshire. A saline chalybeate spring. See SCARBOROUGH.

Schooley's Mountain, United States. A weak chalybeate spring.

Scolliefes, Switzerland. An acidulous chalybeate spring.

**Sea-water*. See SEA and the former part of this article.

**Sedlitz*. A saline water. See SEDLITZ.

**Seltzer*. An highly acidulous water. See SELTZER.

Senec, or *Seend*, Wiltshire. Two chalybeate springs.

**Seydfchutz*, near Sedlitz. A saline water. See SEDLITZ.

Shadwell. A saline chalybeate spring: sulphate of iron?

Shapmoor, Westmoreland. A sulphureous spring slightly saline.

Shettlewood, Derbyshire. A sulphureous spring slightly saline.

Shipton, Yorkshire. A sulphureous spring moderately saline.

Somersham, Huntingdonshire. A chalybeate spring: sulphate of iron. See SOMERSHAM.

**Spa*. Highly acidulous chalybeate springs. See SPA.

Stanger, Cumberland. A saline chalybeate spring.

Stenfield, Lincolnshire. A chalybeate spring slightly saline.

Streatham, Surry. A saline spring. See STREATHAM.

Suchalooza, Germany. An acidulous spring.

Sutton Bog, Oxfordshire. A strong sulphureous spring slightly saline.

Swadlingbar, Cavan. A sulphureous spring.

Swansea, Glamorganshire. A chalybeate spring: sulphate of iron. See SWANSEA.

Sydenham, Kent. A weak saline spring.

Tarleton, Lancashire. A chalybeate spring slightly saline.

Tewksbury, Gloucestershire. A saline spring.

Thetford, Norfolk. A chalybeate spring slightly acidulous.

Thoroton, Nottinghamshire. A chalybeate spring slightly saline.

Thurfsk, Yorkshire. A saline chalybeate spring.

Tibshelf,

WATER.

Tilshelf, Derbyshire. A chalybeate spring slightly acidulous.

Tilbury, Essex. A saline spring slightly chalybeate.

Toberony, near Dublin. A saline spring.

Tonstein, Germany. A saline acidulous spring in considerable repute.

Tralee, Kerry. A chalybeate spring.

**Tunbridge Wells*, Kent. A chalybeate spring. See *TUNBRIDGE WELLS*.

Upminster, Essex. A strong saline sulphureous spring.

Vabls, France. A weak acidulous spring slightly saline.

Vichy, France. A highly acidulo-chalybeate thermal spring. See *VICHY*.

Wardree, Northumberland. A saline sulphureous spring.

Warmbrunn, Silesia. Thermal springs.

Weatherstack, Westmoreland. A saline chalybeate spring.

Wellenbrow, Northamptonshire. A weak chalybeate spring.

West Alkton, Wiltshire. A weak chalybeate spring.

Westwood, Derbyshire. A chalybeate spring: sulphate of iron.

Wexford, Ireland. A weak chalybeate spring.

White Acre, Lancashire. A chalybeate spring.

Wigan, Lancashire. A chalybeate spring.

Wigglesworth, Yorkshire. A sulphureous spring slightly saline.

Wildungan, Germany. A weak acidulous water.

Witham, Essex. A chalybeate spring.

Wirksworth, Derbyshire. A saline sulphureous spring.

Zaborowice, Germany. A weak saline acidulous water.

**Zealand, New*. An acidulous water: muriatic acid.

See the article *AQUÆ*, where many *thermal* and other springs are noticed, which have been omitted in the above catalogue.

Among the older writers on mineral waters, see RUTTY, MONRO, ELLIOT, and others. One of the best modern treatises on mineral waters is doubtless that of Dr. SAUNDERS, to which we have been particularly indebted. Detached essays on particular waters are too numerous to be all noticed. Among the more recent published in this country may be enumerated those of PHILLIPS on the Bath waters; SCUDAMORE on the Tunbridge Wells water; JONES on the Spa waters; and BRANDE on the Cheltenham waters.

The chief of the older writers on the analysis of mineral waters, are BERGMAN and KIRWAN. Latterly, some very valuable essays have been published on this subject by Dr. MURRAY of Edinburgh, of which we have availed ourselves in the above article.

WATER of Crystallization, in *Chemistry*, is a denomination applied to the water attracted by many saline bodies during the act of crystallization. Some salts contain no water of crystallization, while others contain a very large proportion. Water always appears to enter into the composition of crystals in a definite proportion. Water can be commonly separated from salts without affecting their saline properties, and may be restored to them by dissolving them in water, and suffering them to crystallize. See *CRYSTALLIZATION* and *SALTS*.

WATERS, Distilled or Simple, in *Medicine and Pharmacy*, consist chiefly of simple water slightly impregnated with the essential oils of different plants, and are principally used as vehicles for more active remedies. They were formerly very numerous, but their numbers have been very properly much reduced by the moderns. See *AQUÆ Distillatæ*, where all those in common use are enumerated.

WATER, Spirituous, Cordial, or Compound, in *Pharmacy*, &c. was the name formerly given to what are now denominated *Spirits*, the menstruum being alcohol, and the impregnating

ingredients commonly various. See *AQUÆ Cardiacæ*, and *SPIRIT*. For the methods of preparing such compounds, see also *DISTILLATION*, and *OIL, essential*.

WATER, in *Agriculture and Rural Economy*, is a fluid of great utility for many different purposes. The nature of the composition of water, and the great power and capacity which it possesses of taking up and holding a variety of different matters in the state of diffusion or solution, as well as the circumstance of its being every where present amongst almost all kinds of bodies, renders it particularly useful in the growth of plants as crops, and in many other ways. Dr. Woodward, indeed, from finding it to contain the particles of most sorts of extraneous substances, was led to suppose that some of them were the proper matter of nutrition; as water is constantly found to afford so much the less nourishment, the more it is purified by distillation, or other means. So that water, as such merely, did not appear to be the proper nutriment of vegetables, but only the medium or vehicle that contains the nutritious particles or properties, and which conveys them along with it through all the parts of the plant. The more full and complete knowledge of the nature and properties of water which has since been acquired, have, however, set the matter in a more clear and satisfactory point of view. See the article *WATER*.

Water is seldom, if ever, met with in a state of perfect purity, nor often in that even which is sufficiently so for the different operations and uses to which it may be necessary to apply it. Nor have all the trials that have ever been made been yet capable of producing it perhaps perfectly pure. There seems indeed to be no sort of standard by which the weight and purity of water can be readily and easily ascertained. It is, in fact, a very difficult matter, however useful and advantageous it might be in many different intentions, as water scarcely ever continues for any length of time exactly of the same weight, or perhaps purity; as by reason of the air and caloric, or matter of heat contained in it, much variation in respect to the former continually takes place. The effects which different degrees of heat have on the gravity of water are well shewn by the expansion of it in boiling. It is this which makes the chief difficulty in fixing the specific gravity of water, in the view of settling its degree of purity. The purest water that is capable of being obtained is, however, thought by some, as Mr. Hawksbee, who has made many experiments on the subject, to be eight hundred and fifty times heavier than air. But others, whose trials have not been less numerous or correct, have made it not more than about eight hundred, or eight hundred and thirty-six times heavier than air. From whence this general proportion may perhaps be deduced, which may be considered as a sort of standard in the business, that when the barometer is at 30°, and the thermometer at 55°, then water is eight hundred and twenty times heavier than air; and that in such a state the cubic foot of water weighs one thousand ounces avoirdupois, and that of air 1.222, or $\frac{2}{9}$ ths nearly. (See *WATER*.) There is not, however, any very exact standard in air, as the more water there is contained in the air, the heavier it must of course be; for indeed a considerable part of the weight of the atmosphere appears to arise from the water that is contained in it. Consequently, the nearer any water is found to approach the above standards, the purer it may be concluded to be; which may serve to guide and direct many practical uses and applications of the fluid.

In regard to the properties and effects of water, it is well known to be extremely volatile and expansive, being capable of reduction wholly into the state of vapour, and of being dissipated when exposed to heat and unconfined. In this

this state, when properly confined, it is of great use and application for a variety of purposes. See STEAM.

It is found, however, that water, when heated in an open vessel, acquires no more than a certain determinate proportion or degree of heat, whatsoever may be the intensity or the length of continuance of the fire to which it is exposed; which greatest proportion or degree of it is when it boils in the completest manner. The degree of heat, however, which is necessary to make water boil perfectly, is variable, according as the purity of the water, and the weight of the atmosphere, may happen to be. A knowledge of this may be of considerable utility and benefit in the application of heat to this fluid, in a number of operations, as tending to save time, trouble, and the consumption of fuel.

The ready penetrability and separability of water from the bodies with which it may have united, as well as its properties and powers of cohesion, solution, and coagulation, render it still more extensively applicable and useful on many occasions.

Water is a fluid which, in popular language, is distinguished into many different kinds, according to the qualities of it, and the circumstances under which it makes its appearance, or is found (see the preceding article WATER); as *fresh* water, or that which is perfectly insipid, without any saline or other taste, and inodorous, being that which is the natural and pure state of water: in this state, it is well fitted for most sorts of domestic as well as many other uses: *hard* water, or that in which soap does not completely or uniformly dissolve and diffuse itself, but appears in a sort of curdled or coagulated state: it is certain from this that the dissolving power of hard water is less than that of soft; and that hence it is less fit for washing, bleaching, dyeing, boiling culinary vegetables, watering plants and trees, and many other purposes. It is, for the most part, found, that the hardness of water proceeds either from saline matters, or from the presence of gas. The hardness which arises from saline matters may mostly be discovered and removed by the addition of small quantities, as a few drops, of a solution of fixed alkali; and that which is caused by the latter by-boiling, or exposure to the open air for some length of time. That the waters of springs are hard; but those of rivers soft. That hard waters are remarkably indisposed to corrupt; they even preserve putrescible substances for a considerable length of time; hence they would seem to be best fitted for keeping, especially as they are so easily capable of being softened by a very little of the alkaline solution being added to them. *Putrid* water is that which has acquired an offensive smell and taste by the putrescence of the animal or vegetable substances which are contained in it. This sort of water is of a very pernicious quality, and quite unfit for any purpose. Caustic lime, when put into water, is useful in preserving it longer in a sweet state; and even exposure to the air in broad shallow vessels has the same effect. And water in this putrid state may be, in a great measure, rendered sweet by having a current of fresh air passed through it, from the bottom to the top. Water in this condition is, of course, always to be avoided, except for the purpose of manure, for which, in some cases, it is of great use. *Rain-water*, or that which may be considered as a pure sort of distilled water, but as impregnated during its passage through the air with a considerable quantity of putrescent matter, whence, in some measure, its great superiority to any other in fertilizing the earth or soil, as well as in promoting the growth of trees and plants. Whence too its inferiority for some domestic purposes to that of the spring or river kind, even where it can be readily and well procured; but,

more especially, such as is collected and gotten from spouts, trunks, and other contrivances put below the roofs of houses and other buildings, which are the usual modes of procuring it in this country, which is obviously very impure, and in a short time becomes in the putrid state. From its softness, it, however, answers well in some uses, after it has become pretty pure by standing. *River-water*, or that which is next in purity to that of snow, or the distilled kind, and which, for most domestic and some other uses, is superior to either of them, as having less putrescent matter, and more fixed air, or carbonic acid gas in it. Of this water, that, however, which runs over a clean, rocky, stony, or gravelly bottom, is by much the purest. *River-waters*, in general, are found to putrefy sooner than those of springs; and that during their putrefaction they throw off a part of the extraneous matter they contain, and at length become sweet again, and purer than in their first state; after which they will commonly preserve sweet a great length of time; this is particularly the case with some river-water, as that of the Thames. It is this sort of water that is so extensively useful in improving grass-lands, when thrown over them in a proper manner. See WATERING Land, and WATER Meadow.

There are some other sorts of water, as *salt* water, or that which contains large portions of salt in it, so as to be sensible to the taste. This is of most use in the preparation of that substance from it, but may perhaps be applicable in some other ways. *Sea-water*, or that which is a sort of an assemblage of bodies or substances, in which this fluid may be said to have barely the principal part: it is, in short, an universal collection of most of the matters in nature, sustained and kept swimming in this fluid as a medium or vehicle: being a diffuse solution of various substances, as common salt, bitter cathartic salt, different other saline matters, and a compound of muriatic acid with magnesia, mixed and blended together in a variety of proportions. It is capable of being freshened by simple distillation, without any addition; and is about three parts in a hundred heavier than common water; the temperature of it at great depths being from thirty to forty degrees; but near the surface it follows the temperature of the air more nearly. It is probable, from some trials lately made with it, that it may be useful when applied to land in some cases. Its greater weight and other properties would seem to be favourable for this in some intentions. It is the muddy material conveyed in the state of diffusion in this water, which is found so beneficial in the warping of land in some cases and situations. (See WARPING of Land.) *Snow-water*, or that which is the purest of all the common waters, when the snow has been collected in its pure state, and kept in a dry place, in clean glass vessels, not closely stopped, but covered from dust and other such matters; this water becomes in time putrid, although in well-stopped bottles it will continue unaltered for several years; but distilled water undergoes no alteration in either circumstance. Snow-water will be seen below to be useful in promoting the nutrition of plants. *Spring-water*, or that which is commonly impregnated with some sorts of materials or other, as a small portion of imperfect neutral salt extracted and taken up from the different strata through which it passes and percolates; great quantities of stony matter, which are deposited as it runs along, and large masses of stone thus formed, sometimes too incrustating different substances of the animal and vegetable kinds, which it is said to petrify. Spring-water is much used for domestic purposes in many cases, and on account of its coolness and clearness forms a suitable drink for man and animals; but from its being usually somewhat hard, is inferior in some intentions to that which has run a considerable distance

in an open channel, exposed to the action and influence of the air.

The water of springs arises and is caused by rain, and from mists and moisture in the atmosphere; which falling upon the hills and higher grounds, as well as other parts, soak in and sink down into the earth, passing along between the different strata, until they find a vent or outlet in the form of a spring. See *DRAINING of Land*, *SPRING*, and *WALL*. Also *SPRING-Draining*.

It is only under certain circumstances that spring-water can be applied over the surface of grass-land with much benefit; as where it is considerably impregnated and loaded with particular sorts of materials, as those of the calcareous, and perhaps some other kinds.

A late philosophical writer has remarked, that the necessity of much water in the progress of the growth of plants or their vegetation, is shewn by the great quantity which exists naturally in all parts of them; inasmuch that many roots, as those of the squill and rhubarb, are known to lose about six parts out of seven of their original weight, simply by drying them before the fire; which quantity of moisture nevertheless does not exhale in the common heat of the atmosphere during the life of the root; as may be seen in the growth of squills in the shop of the druggist, and of onions on the floors of the store-rooms of the seedsmen. And that a second necessity of much water in the economy of their vegetation or growth may be deduced from the great perspiration of them, which appears from the experiments of Hales and others, who, like Sanctorius, have, it is said, estimated the quantity of perspiration from their daily loss of weight; which, however, it is suggested, is not an accurate conclusion, either in respect to plants or animals, as they both absorb moisture from the atmosphere, as well as perspire it. But that this great perspiration of vegetables, like that from the skin and lungs of animals, does not appear to consist of excrementitious matter, because it has in general no putrescent smell or taste, but seems to be secreted first for the purpose of keeping the external surface of the leaves from becoming dry, which would prevent the oxygen of the atmosphere from entering into the vegetable blood or juice through them; since, according to the experiments of Dr. Priestley on animal membranes, the oxygen will only pass through them when they are moist. A second use of this great perspiration is, it is said, to keep the bark supple by its moisture, and thus to prevent its being cracked by the motion of the branches in the wind. And though a great part of this perspirable matter is probably absorbed, as on the skins of animals, yet as it exists on so large a surface of leaves and twigs, much of it must necessarily evaporate on dry and windy days.

And the discovery of the decomposition of water has, it is said, led to a third great use of water in the vegetable economy, which is probably owing to its ready decomposition by their organs of digestion, sanguification, or juice-forming, and secretion. This is evinced, it is thought, first, by the great quantity of hydrogen which exists in the composition of many of their inflammable parts; and secondly, from the curious circumstance which was first discovered by the ingenious Dr. Priestley, that the water which they perspire is hyper-oxygenated, and in consequence always ready to part with its superabundance of oxygen, when exposed to the sun's light; whence it may be concluded, it is thought, that a part of the hydrogen, which was previously an ingredient of this water, has been separated from it, and used in the vegetable economy. And that, from the decomposition of water, when confined in contact with air beneath the soil, the nitrous acid seems to be produced, and

ammonia, both of which are believed to be useful to vegetation and the growth of plants.

But that, beside these peculiar uses of a great quantity of water, the more common uses of it both to vegetable and animal life, along with caloric or the matter of heat, are to produce or preserve a due suppleness or lubricity of the solids, and a due degree of fluidity of liquids which they contain or circulate; and, lastly, for the purpose of dissolving or diffusing in it other solid or fluid substances, and thus rendering them capable of absorption, circulation, and secretion.

It is beneficial, too, in the view of promoting the fertility of grass-lands, by the occasional suffusion or flowing it over them, by which it not only supplies simple moisture for the purposes above noticed in the drier parts of the season, but brings along with it calcareous earth and azotic air from the neighbouring springs in many instances, or other manures from the rivers and brooks. Still another beneficial consequence of it is to give a due penetrability to the soil or mould, which otherwise, in most situations, becomes so stiff and hard, as to stop the elongation and distension of the tender roots of plants; but nevertheless, the cohesion of the soil or earthy particles may be too much or too greatly diminished or lessened, by great and perpetual moisture, so as not to give sufficient firmness to the roots of trees or plants. It may also be injurious in some cases, as in very hasty showers, by washing off and taking away much of the decomposing animal and vegetable recrement, which are soluble or diffusible in it, and carrying them down the rivers and brooks into the sea; and from the sides of hills, injury in this way is produced by small showers; and the evaporation of water or moisture from the surface of the earth may produce so much cold as to injure such terrestrial plants as are too long covered with it.

The author of the "Elements of Agricultural Chemistry" has concluded, that water is absolutely necessary to the economy of vegetation, both in its elastic and fluid state; and that it is not devoid of use, even in its solid form. Snow and ice are, it is said, bad conductors of heat; and that, consequently, when the ground is covered with snow, or the surface of the soil or of water is frozen, the roots or bulbs of the plants beneath are protected by the congealed water from the influence of the atmosphere, the temperature of which, in northern winters, is usually very much below the freezing-point; and this water becomes the first nourishment of the plants in early spring. The expansion of water too during its congelation, at which time its volume increases one-twelfth, and its contraction of bulk during a thaw, tend, it is observed, to pulverize the soil, to separate the parts of it from each other, and to make it more permeable to the influence of the air, and the fibres of the roots of vegetables.

Water also, as constituting the daily necessary drink of the different sorts of domestic animals which form the livestock of the farmer, is always to be particularly attended to, and to be provided as fully and of as good quality as can possibly be met with; as such stock constantly do best where they have plenty of water. See *POND*, and *LIVE-Stock*.

Application of water, whether of ponds, brooks, rivers, or other kinds, to the purpose of fisheries, is likewise a matter of great individual utility and benefit, as well as general national advantage. It is the means of increasing a most useful sort of food in almost an unlimited manner, at very little cost or expence. It provides much profitable labour and employment to some of the working classes of society; and from the trifling charge incurred in providing it,

and the readinefs of its difpofal, muft be a fource of great wealth to the country. It fhould, of courfe, be encouraged as much as poffible, wherever it can be done with convenience and fuccefs, in all parts of the kingdom. See *FISH-Pond*, *POND-Fifberies*, and *SALMON-Fifberies*.

WATER, *Afcend of*, in *Hydraulics*. See *ASCENT* and *CAPILLARY Tubes*.

WATER, *Highb and Low*. See *FLUX*, *HIGH*, and *TIDE*.

WATER, *Motion of*. The theory of the motion of running water is one of the principal objects of hydraulics, and many eminent mathematicians have applied themfelves to this fubject. But it were to be wifhed that their theories were more confiftent with each other, and with experience. The curious may confult fir Ifaac Newton's *Principles*, lib. ii. prop. 36. with the comment. Dan. Bernouilli's *Hydrodynamica*. Jo. Bernouilli, *Hydraulica*, Oper. tom. iv. p. 389, feq. Dr. Jurin, in the *Phil. Tranf.* N^o 452, and in Dr. Martyn's *Abridg.* vol. viii. p. 282, feq. S'Gravafande, *Phyfic. Elem. Mathemat.* lib. iii. par. ii. Polenus, de *Caftellis*, and others.

Mr. Maclaurin, in his *Fluxions*, art. 537. feq., has illuftrated fir Ifaac Newton's doctrine on this intricate fubject, which ftill, notwithstanding the labours of all thefe eminent authors, remains in a great meafure obfcure and uncertain. Even the fimple cafe of the motion of running water, which is when it iffues from a hole in the bottom of a vefel kept constantly full, has never yet been determined, fo as to give univerfal fatisfaction to the learned. We fhall here mention fome of the phenomena of this motion, as ftated by Dr. Jurin from Poleni; referring for other obfervations on this fubject to *FLUIDS*, and *Hydraulic Laws of FLUIDS*.

1. The depth of the water in the vefel, and the time of flowing out being given, the meafure of the effluent water is nearly in proportion to the hole.

2. The depth of the water, and the hole being given, the meafure of the effluent water is in proportion to the time.

3. The time of flowing out, and the hole being given, the meafure of the effluent water is nearly in a fubduplicate proportion to the height of the water.

4. The meafure of the effluent water is nearly in a ratio compounded of the proportion of the hole, the proportion of the time, and a fubduplicate proportion of the depth of the water.

5. The meafure of the water flowing out in a given time, is much lefs than that which is commonly affigned by mathematical theorems. For the velocity of effluent water is commonly fuppofed to be that which a heavy body would acquire *in vacuo* in falling from the whole height of the water above the hole; and this being fuppofed, if we call the area of the hole *F*, the height of the water above the hole *A*, the velocity which a heavy body acquires in falling *in vacuo* from that height *V*, and the time of falling *T*; and if the water flows out with this conftant velocity *V*, in the time *T*, then the length of the column of water, which flows out in that time, will be $2 A$, and the meafure of it will be $2 A F$. But if we calculate from Poleni's accurate experiments, we fhall find the quantity of water which flows out in that time to be no more than about $\frac{5}{7} \frac{2 A F}{T}$ of this meafure $2 A F$. Polen. de *Caftellis*, art. 35. 38. 39. 42. 43.

Poleni alfo found, that the quantity of water flowing out of a vefel through a cylindrical tube far exceeded that which flowed through a circular hole made in a thin lamina, the tube and hole being of equal diameter, and the height of the water above both being alfo equal; and he found it to be fo when the tube was inferted, not into the bottom, which others had obferved before, but into the fide of the vefel.

6. Since the meafure of the water running out in the time *T*, is $2 A F \times \frac{5}{7} \frac{2}{T}$, the length of the column of water, which runs out in that time, is $2 A \times \frac{5}{7} \frac{2}{T}$. Therefore if each of the particles of water, which are in the hole in the fame fpace of time, paffes with equal velocity, it is plain that the common velocity of them all is that with which the fpace $2 A \times \frac{5}{7} \frac{2}{T}$ would be gone over in the time *T*, or the velocity $V \times \frac{5}{7} \frac{1}{T}$. But this is the velocity with which water could fpring *in vacuo* to near $\frac{1}{3}$ of the height of the water above the hole.

7. But when the motion of water is turned upwards, as in fountains, thefe are feen to rife almoft to the entire height of the water in the ciftern. Therefore the water, or at leaft fome portion of the water, fpouts from the hole with almoft the whole velocity *V*, and certainly with a much greater velocity than $V \times \frac{5}{7} \frac{1}{T}$.

8. Hence it is evident, that the particles of water, which are in the hole in the fame point of time, do not all burft out with the fame velocity, or have no common velocity; though fome mathematicians have hitherto taken the contrary to be certain.

9. At a fmall diftance from the hole, the diameter of the vein of water is much lefs than that of the hole. For inftance, if the diameter of the hole be 1, the diameter of the vein of water will be $\frac{2}{7}$, or 0.84, according to fir Ifaac Newton's meafure, who firft obferved this phenomenon;

and according to Poleni's meafure $\frac{20}{26}$, or $\frac{20\frac{1}{2}}{26}$, that is, taking the mean diameter 0.78, nearly.

As to the manner of accounting for thefe phenomena, we have already obferved that authors are not agreed; and it would be far beyond our defign to ftate their different theories, we muft therefore refer to the originals above quoted.

Neither are authors agreed as to the force with which a vein of water, fpouting from a round hole in the fide of a vefel, preffes upon a plane directly oppofed to the motion of the vein. Moft authors agree that the preffure of this vein, flowing uniformly, is equal to the weight of a cylinder of water, the bafis of which is the hole through which the water flows, and the height of which is equal to the height of the water in the vefel above the hole. The experiments made by Mariotte, and others, feem to countenance this opinion. But Mr. Daniel Bernouilli rejects it, and eftimates this preffure by the weight of a cylinder, the diameter of which is equal to the contracted vein (according to fir Ifaac Newton's obfervation above-mentioned), and the height of which is equal to twice the height of the water above the hole, or, more accurately, to twice the altitude correfponding to the real velocity of the fpouting water; and this preffure is alfo equal to the force of repulfion, arifing from the reaction of the fpouting water upon the vefel. For he fays that he can demonftrate, that this force of repulfion is equal to a preffure exerted by a vein of fpouting water upon a plane directly oppofed to its motion, if the whole vein of water ftrikes perpendicularly againft the plane. From whence it would follow, that the preffure or force of the vein will be greater in proportion, as its contraction is lefs; and this contraction vanifhing, as it does when the water fpouts through a fhort tube, and the vein being at the fame time fuppofed to have the whole velocity it can acquire by theory, the fpouting water will then exert a preffure double to what is commonly fuppofed. But the actual velocity of the water being always fomething lefs than it ought to be by theory, and the vein of water being not uncommonly contracted to almoft one half, experi-

periments have led authors to think, that the pressure, exerted by spouting water, was equal to the weight of a cylinder of the same diameter with the vein, and of the height of the water above the hole. The ingenious author remarks that he speaks only of single veins of water, the whole of which are received by the planes upon which they press; for as to the pressures exerted by fluids surrounding the bodies they press upon, as the wind, or a river, the case is different, though confounded with the former by writers on this subject. *Hydrodynamica*, sect. 13. p. 289.

M. Bernouilli endeavours to confirm his theory by a dissertation in the eighth volume of the *Acta Petropolitana*; where he observes, that the experiments formerly made before the Academy of Sciences at Paris, to establish the quantity of the pressure exerted by a vein of spouting water, are very far from proving the truth of the rule they are brought to establish. For instance, in one of those experiments, the height of the water in the vessel above the hole from whence the vein spouted was two feet Paris measure; the diameter of the circular hole, which was cut in the horizontal bottom of the vessel, was four lines; and the force of the vein of water was observed to be one ounce and three-quarters. But the weight of a cylinder of water of the diameter of the hole, and of the height of the water in the vessel, is scarce equal to one ounce and three-eighths. The difference, therefore, is at least three-eighths of an ounce, which is about three-elevenths of the whole weight of the before-mentioned cylinder of water. So that it is surprising, that this difference should have been ascribed to the removal of the plane, receiving the impulse, to some distance from the hole; for this cause, supposing the plane removed to the distance of two inches, could not produce an increase of one-sixteenth of an ounce. It appears, therefore, that the common opinion is rather overturned than confirmed by experience. *Du-Hamel*, *Hist. Acad. Paris*, ann. 1679, sect. 3. cap. 5.

M. Bernouilli, on the other hand, thinks his own theory sufficiently established by the experiments he relates; for the particulars of which, we refer to the *Acta Petropolitana*, vol. cit. p. 122, seq.

This ingenious author thinks that his theory of the quantity of the force of repulsion, exerted by a vein of spouting water, might be usefully applied to move ships by pumping; and he thinks the motion produced by this repulsive force would fall little, if at all, short of that produced by rowing. He has given his reasons and computations at length in his *Hydrodynamica*, p. 293 to 302.

The science of the pressures exerted by water, or other fluids in motion, is what M. Bernouilli calls *hydraulico-statica*. This science differs from hydrostatics, which considers only the pressure of water and other fluids at rest; but hydraulico-statics considers the pressure of water in motion. Thus the pressure exerted by water, moving through pipes, upon the sides of those pipes, is an hydraulico-statical consideration, and has been erroneously determined by many, who have given no other rules in these cases, but such as are applicable only to the pressure of fluids at rest. See *Hydrodynam.* sect. 12. p. 256. seq.

WATER, Raising of. Machines for this purpose are so numerous, that a minute description of such hydraulic machines as are in common use would fill a volume; and a scientific account of their principles, with the maxims necessary to be observed in their construction, would form a very complete body of mechanical science: this is far beyond the limits of an article like the present, in which we can only introduce the most striking machines which

have not already been explained in different articles of this work; and for others, we must refer to the original works in which they are described.

The most complete collection of hydraulic machines is that of Jacob Leopold, entitled "*Theatrum Machinarum Hydraulicarum*," published at Leipzig, in 1724 and 1725, in 2 vols. folio; these form part of his voluminous "*Theatrum Machinarum*," which may be considered as containing all that was known in mechanics at that period.

M. Belidor, in his "*Architecture Hydraulique*," 1737, has described many machines which were invented since the date of Leopold's work. This eminent engineer was a good mathematician, and his work may be considered as a standard for the theory of the hydraulic machines of which it treats. The "*Experimental Philosophy*" of Defaguliers contains some chapters on hydraulic machinery, in which he generally follows Belidor very closely, but has translated the mathematical investigations of the former into the ordinary processes of arithmetic, to adapt them to the comprehension of mechanics; and in this point of view, the works of Defaguliers have been of great use. On the other hand, M. Prony published a modern edition of Belidor's work in 1790, in which, in most cases, he has transferred the processes of the original into the modern modes of analysis; but on the whole, he has added little to our real knowledge, except his descriptions and superb plates of Mr. Watt's steam-engine.

We do not recollect any complete collection of machines for raising water since Belidor, although the inventions of the last century are both numerous and important. Much information relative to them may be derived from Gregory's "*Mechanics*," in 2 vols. 8vo.; Dr. Robison's *Works*, and his excellent articles *Hydrodynamics*, *Pump*, and *Waterworks*, in the *Encyclopædia Britannica*; and from various miscellaneous publications, such as the *Repertory of Arts*, and the *Transactions of different learned Societies*; also the collection of Mr. Smeaton's *Reports*, in 3 vols. 4to. It is much to be regretted, that this excellent engineer never completed a design which he formed, to publish a complete collection of practical hydraulic machines founded on his own experience. Among his manuscript papers which have been lent to us by sir Joseph Banks, we find an outline for this work, of which we have availed ourselves in this article.

In considering machines for raising water, they may be classed under two heads:

First, those machines which actuate some kind of bucket or vessel adapted to contain water, which vessel is raised up when full of water, and discharges its contents into an elevated reservoir, then descends empty in order to repeat its action: of this species are, the buckets for wells, scoops, Persian and Chinese wheels, chaplets or chains of buckets, the Noira, and the screw of Archimedes. It is evident from the nature of all this class, that they are incapable of raising water to a greater height than that to which the machine is elevated, or provided with the means of drawing up the buckets or other vessels; and further, that they cannot raise constant streams of water, but that the water must be given out by a succession of discharges from the different buckets or vessels.

The second class comprises those machines which act by means of valves and pistons moving in cylinders, or other equivalent contrivances, and force the water to ascend through pipes or tubes: these machines have the advantage of raising the water to very great heights above the place where the machine is placed. The greater part of these machines we have already described under the article **PUMP**,

and there remain but few to be considered in the present article; viz. the varieties of the hydraulic ram, of the Chrennitz fountain, and of the fyphon machines.

The most obvious means of raising water is by the operation called baling, that is, lifting up water in a bucket, or other vessel, by the force of a man's arm. This method is extremely fatiguing, and is only adapted to very small elevations, such as clearing the water from a boat, &c. The most ancient hydraulic machine acts on this principle, such as the scoop and troughs, the Fen wheel, Persian wheel, the Noira, &c.: it is, therefore, with these machines we shall commence.

The *Dutch water-scoop*, or shovel, is the best means of baling out water. The scoop is a kind of box, made of five pieces of board, with one end and one side open: this box is fixed at the extremity of a long pole, which the workman holds in his hand, and the weight of the scoop is borne by a cord tied to the pole near to the box, and suspended from a tripod, formed of three poles tied together at the top. The man works the machine by swinging the scoop backwards and forwards in the direction of the length of the pole; in moving the box forwards, he depresses the end of the pole, which causes the box to dip into the water, and take up a quantity which it will throw forwards and rather upwards to a considerable distance. In bringing the scoop back for another stroke, he depresses the end of the pole which he holds in his hand, and thus keeps the box out of the water. Of course this method is only applicable where the height to which the water is to be raised, or rather thrown, is very small. M. Belidor informs us, that a workman can only remove half a cubic foot in two vibrations, which he will perform in four seconds; this is at the rate of $7\frac{1}{2}$ cubic feet *per* minute, or 450 cubic feet *per* hour: it is rarely applicable, except to throw the water over a bank which forms the boundary of a ditch, or other place of small depth, which is to be emptied.

The *laving gun*, which is used in salt-works from its simplicity, comes next. It is a trough of five or six feet in length, made small at one end like a spout, and gradually increasing to the opposite end, where it is about a foot or eighteen inches square. The small end is supported on pivots upon the bank over which the water is to be raised, and a lever is applied to it for a man to work it by. The large end of the trough will dip into the water, when it descends and becomes filled; but when lifted the least above the horizontal position, the contained water will run along the trough, and be delivered over the bank through the spout. This machine is much improved by making it double, or with two troughs, on the opposite sides of the centre; thus when one ascends, the other will descend so as to raise up a constant stream, which it must, in this case, deliver at a spout sideways, near to the pivot or centre on which it plays. This double machine will raise a copious stream of water, but is confined to small heights of three or four feet. If the large end of the trough has a valve opening into it to admit the water, it will fill itself more readily. A machine which operates on the same principle as this, is called the scoop-wheel, or tympanum, which is in fact several double laving machines arranged round the centre like a wheel. The advantage of this wheel is, that it always moves in the same direction, whereas the simple machine requires a reciprocating motion.

The *tympanum*, or *scoop-wheel*, mentioned by Vitruvius, is a great hollow wheel formed by a kind of barrel or drum (as its name imports): it is composed of several planks joined together, well caulked and pitched, and having a ho-

izontal axle with pivots at the ends, on which it turns. The interior capacity of this drum is divided into eight equal spaces, by as many partitions placed in the directions of the radii; each space or cell has an orifice of about six inches in width in the rim of the drum or wheel. These openings are so shaped, as to facilitate the admission of the water; moreover, there are eight hollow channels running along the axle of the wheel and contiguous to each other, each corresponding to one of the eight large cells; into these channels the water passes out of the cells just mentioned, and after running along the channels in the axis of the wheel to a convenient distance, it escapes through orifices into a reservoir placed just under the axle. Thus when the wheel is turned round, the water is elevated through a vertical height equal to the radius of the hollow wheel.

When the tympanum is used to raise water from a running stream, it is moved by means of float-boards fixed on the circumference, which are impelled by the stream; but when it is employed to raise stagnant waters, there is commonly a smaller hollow wheel fixed on the shaft at the side of the tympanum, which is turned by men walking in it, as in the old walking-crane. The chief defect of this machine is, that it raises the water in the most disadvantageous situation possible, for the load of water is always towards the extremity of a radius of the wheel, and the length of the effective lever which answers to it must continually increase as the water is raised through the whole quadrant, which the water describes in passing from the bottom of the wheel to the altitude of its centre, so that the power must act in the same manner as if it were applied to a winch or crank handle, and cannot act uniformly.

The *horn-wheel* was contrived to remedy this defect: it is so called, because the segments which pass from the circumferences of the large flat cylinder to its centre are not straight radii, as in the former instance, but are curved spirally. The scoops, or mouths, by turns, dip into the water, and as they rise up cause the water to pass up the horn, or curved segment, until it is as high as the centre of the wheel, and then it is discharged into a trough placed under the end of the axis, which is hollow, and has its pivots fastened to a cross.

M. de la Faye has investigated the proper curves for the scoop segments of this machine in the following manner:—When we evolve the circumference of a circle by unwrapping a string from the circumference, the end of the string will describe a curve called the involute of the circle, of which all the radii are so many tangents to the circle, as is shewn by the string in its different positions whilst tracing the curve, and likewise all the radii are respectively perpendicular to the several points of the curve described by the end of the string.

The greatest radius of this curve is a line equal to the periphery of the circle evolved. The truth of this statement is shewn by geometricians, when treating of the generation of *Evolute* and *Involute Curves*. See those articles.

Hence, having an axle, whose circumference a little exceeds the height to which the water is proposed to be elevated, let the circumference of the axle be evolved, and it will make a curve which will be the involute of the circle, as before mentioned. Now, let a number of pipes, or trunks, be made exactly with this curvature, and then put together around the axle, in form of a wheel, so that the further extremities of these canals will successively enter the water that is to be elevated, whilst the other extremities abut upon the shaft which is turned. Then, in the course of the rotation of the wheel, the water taken in at the extremity of each canal will rise in a vertical line, which is a tangent to

WATER.

to the shaft, because the curves of the several channels will be at right angles to this vertical line, in the points where the line intersects the curves; and this is true in whatever position the wheel may be. Thus the action of the weight continuing always beneath the extremity of the horizontal radius of the axle, will oppose the same resistance, as though it acted upon the invariable arm of a lever, in the manner of a bucket of water, which is drawn up out of a well by a rope, winding on a roller, and the power required to raise the weight will be always the same.

If the radius of the wheel, of which these hollow canals serve as bent spokes, be equal to the height through which the water is to be raised, and consequently equal to the circumference of the axle, or shaft, the power will be to the load of water reciprocally as the radius of a circle to its circumference, or directly as 1 to $6\frac{1}{2}$ nearly. M. de la Faye recommended the machine to be composed of four of these canals, but it has often been constructed with eight. The wheel is turned by the impulsion of the stream upon float-boards fixed on the circumference of the wheel, and the orifices of the curvilinear canals dip one after another into the water which runs into them; and as the wheel revolves, the fluid rises in the canals, until it is as high as the centre: it then runs out in a stream from the holes in the axis, and is received into the trough fixed beneath the axis; and thence it may be conveyed by pipes or troughs to the required situation.

By this construction, the weight to be raised offers always the same resistance, and that is the least possible, while the power is applied in the most advantageous manner which the circumstances will admit of. These conditions being both fulfilled at the same time, furnish the most desirable perfection in a machine. This machine raises the water by the shortest way, namely, the perpendicular or vertical line, and in this respect is preferable to Archimedes's screw, where the water is carried up a crooked and inclined path; and besides this each curved channel in this wheel empties all the water it receives in every revolution, while the screw of Archimedes delivers only a small portion of the fluid with which it is charged, being often loaded with twenty times as much water as is discharged at one rotation, and thus requiring an increase of labour when a large quantity is intended to be raised by it. The horn-wheel would be one of the most perfect machines for raising water, were not its powers confined to such altitudes as the semi-diameter of the wheel.

The *flash*, or *fen-wheel*, comes next to be described.—This is a vertical wheel, made exactly like those water-wheels for turning mills which are called breast-wheels, and in the same manner the wheel is surrounded at the lower quadrant by a curved sweep of masonry or breast, to which the floats of the wheel are fitted with the greatest accuracy, but do not absolutely touch. This wheel, being turned round in a direction contrary to that in which a water-wheel turns, will carry water before its floats, and raise it up against the breast until it runs over the same. The operation is just the reverse of the water-wheel; and the only difference in the construction of the two machines is, that the flash-wheel requires no shuttle to be placed at the top of the breast, because the water must be allowed to run freely away from the top of the breast; but the water-wheel requires a shuttle or sluice to regulate the quantity of water which shall flow to the wheel.

It is by this kind of machine that the extensive fens of Holland are drained; and in Lincoln and Cambridgeshire they are also used very extensively. They are, in general,

worked by the power of the wind, and are on a very large scale.

Mr. Smeaton made a horse-machine on this plan, which raised thirty-three hogheads *per* minute, to the height of four feet and a half, when it was worked by four horses; but a sluice was placed in the channel which admitted the water to the wheel, so as to supply the water in a greater or lesser quantity; and by this means, the same machine could be adapted to the power of three or two horses. The crown or top of the breast, over which the water was delivered, was not elevated to the full height to which the water was to be raised, but it was laid twelve inches beneath the surface, and the body of water which the wheel raised up was sufficient to drive this depth of water before it; but to prevent the return of the water when the mill ceased working, two pointed doors were placed in the channel leading from the wheel, like the gates of a canal-lock: these doors opened freely, to let the water pass, but would shut and stop the water from returning. The proportions of this machine were as follows:

Diameter of the track in which the	}	26 feet 8 inches.
horses walked - - -		
Great cog-wheel fixed on the per-	}	72 teeth 9 feet dia-
pendicular axis - - -		
Trundle worked by the wheel -	-	35 teeth $4\frac{1}{2}$ feet diam.
Diameter of the water-wheel on the	}	14 feet.
same axis as the trundle - - -		
Breadth of the wheel - - -	-	2 feet 2 inches.
Number of its floats - - -	-	42

The floats did not point to the centre of the wheel, but formed tangents to a radius, equal to about half the radius of the wheel. The floats of the wheel were very exactly fitted to the channel or pit in which it worked, so as not to touch.

The *bucket-wheel* is a very ancient method of raising water; but it cannot lift water to a greater height than its own diameter. The last machine was the reverse of the breast water-wheel, and the present is the reverse of the over-shot water-wheel, for the circumference of the wheel is surrounded by buckets, which dip in the water beneath the wheel, and take up water, which they discharge at the top of the wheel into an elevated trough or reservoir. The wheel is mounted upon an horizontal axis, and turns upon pivots; it is put in motion by the force of a current of water striking the float-boards fixed on the circumference of the wheel; or if there is no current in the water, it may be moved by making the wheel hollow within for a man to walk in it, as is common in some kinds of cranes, or the wheel may be turned by horses. The rim, or circumference of the wheel, is made hollow, and is divided into several compartments, to form a number of boxes or buckets; each bucket has an opening into it at that end which will be the most advanced when the wheel turns; and from this opening, a spout or trough projects in a direction parallel to the axis of the wheel. When the wheel revolves, the buckets dip into the stream, and become filled with water; but as the mouths or spouts are at the upper end when the buckets rise out of the water, they cannot escape, and each bucket carries up its charge of water to the top of the wheel; but the buckets will have then become inverted, and the spouts or openings being at the lowest part, that they discharge the water sideways through the spouts into a trough properly placed to receive it, and then the buckets descend empty till they dip into the stream and are refilled. The objection to this machine is, that the buckets begin to pour out the water
some

some time before they arrive at the greatest height of the wheel; and, therefore, the trough is of necessity placed lower than the diameter of the wheel, or a considerable portion of the water would be lost, and in any case part of the water is raised above the level of the trough.

Spanish Bucket-Wheel.—Mr. Townsend, in his Travels through Spain, describes a simple machine which is used at Narbonne for watering of gardens. The water is raised by a vertical wheel, which is twenty feet in diameter, on the circumference of which is fixed a number of little boxes or square buckets, for the purpose of raising water out of the cistern communicating with the canal below, and to empty it in a reservoir above, placed by the side of the wheel. The buckets have a lateral orifice to receive and to discharge the water. The axis of this wheel is embraced by four small beams, crossing each other at right angles, and tapering at the extremities so as to form eight little arms. This wheel is near the centre of the path in which the mule walks, and contiguous to the vertical axis, into the top of which the horse-beam is fixed; but near the bottom of this axis it is embraced by four little beams, forming eight arms, similar to those above described, on the axis of the water-wheel. As the mule which they use goes round, these horizontal arms, supplying the place of cogs, take hold each in succession of those arms which are fixed on the axis of the water-wheel, and keep it in rotation. This machine may be made very cheap, and will throw up a great quantity of water, yet undoubtedly it has two defects; the first is, that part of the water runs out of the buckets, and falls back into the well after it has been raised nearly to the level of the reservoir; and the second is, that a considerable proportion of the water to be discharged is raised higher than the reservoir, and falls into it only at the moment when the bucket is at the highest point of the circle, and ready to descend.

The *Persian wheel with swinging buckets* is free from some of the defects of the last machine. The buckets are loose, and each hangs from the circumference of the wheel by a pin, on which it swings or turns freely; and as the bucket is suspended by its upper part, it will hang perpendicular, with the mouth upwards, in all positions of the wheel. From the time it dips in the water and is filled, until the bucket arrives at the upper part of the wheel, it is carried by the motion of the wheel against the edge of the trough, and inclined so far as to discharge its contents into the trough. (See *Persian Wheel*.) The pins are fixed into the circumference of the wheel, and project sideways therefrom a sufficient distance to support the buckets, and carry them over the elevated trough. Sometimes the wheel is made with two rims, and each bucket is suspended upon an axis between them: the end of each axis passes through the rim of the wheel, and is bent to form a short lever, which is carried by the motion of the wheel against a fixed rail, and thus inclines the bucket to discharge the contents into a trough which is fixed to the rims of the wheel immediately beneath the bucket, and has a spout projecting at the side of the wheel, to carry the water sideways and deliver it into the trough, which is fixed at the side of the wheel for its reception.

As the Persian wheel is a very effective machine in situations where the elevation is required to be but small, the following directions, given by M. Belidor for its construction, are worthy of attention: first fix the diameter of the wheel something greater than the altitude to which the water is to be raised; fix also upon an even number of buckets, to be hung at equal distances round the periphery of the wheel; and mark the position of their centres of motion in such a

manner, that they will stand in corresponding positions in every quarter of the circle. Suppose vertical lines drawn through the centre of motion of each bucket in the rising part of the wheel, and they will intersect the horizontal diameter of the wheel in points, at which, if the buckets were hung, they would make the same resistance to the moving force, as they do when hanging at their respective places on the rim of the wheel. Thus, supposing there are eighteen equidistant buckets, then while eight hung on each side of a vertical diameter of the wheel, there would be eight on the other side, and two would coincide with that diameter: in this case, the resistance arising from all the full buckets would be the same as if one bucket hung on the prolongation of the horizontal diameter, at the distance of twice the sine of 20° + twice the sine of 40° + twice the sine of 60° + twice the sine of 80° , these being the sines to the common radius of the wheel.

To know the quantity of water that each one should contain, take four-ninths of the absolute force of the stream, that is, four-ninths of the weight of a prism of water whose base is the surface of one of the float-boards, and whose height is equal to that through which the water must fall in order to acquire the velocity with which the stream moves. This is the power which should be in equilibrio with the weight of water contained in the buckets of the rising semicircle. Then say, as the sum of the sines mentioned above is to the radius of the wheel to the centre of the float-board, so is the power just found to a fourth term, one-half of which will be the weight of water that ought to be contained in each bucket. Lastly, the velocity of the float-board of the wheel will be to that of the stream nearly as one to two and two-fifths, and from this the number of revolutions it will make in any determinate times may be known, and of consequence the quantity of water the wheel will raise in the same time, since we know the capacity of each bucket, and the number of them which will be discharged in every revolution of the wheel. See *Persian Wheel*.

The Chinese Bucket-Wheel.—Sir George Staunton, in his account of the Embassy to China, gives the following description of a bucket-wheel, which is different from any we have met with in the hydraulic collections, and constructed with that simplicity which distinguishes the Chinese inventions. Two hard-wood posts or uprights are firmly fixed in the bed of the river, in a line perpendicular to its banks. These posts support the pivots of an axis of about ten feet in length: this is the axis of a large wheel consisting of two unequal rims, the diameter of the rim which is nearest to the bank being about fifteen inches less than that of the outer rim; but both rims dip into the stream, while the opposite points or top of the wheel rise above the elevated bank over which the water is to be raised. This double wheel is framed upon the axis, and is supported by sixteen or eighteen spokes, inserted obliquely into the axis near each extremity, and crossing each other at about two-thirds of their length. They are there strengthened by a concentric circle, and are fastened afterwards to the two rims. The spokes inserted in the interior extremity of the axis reach to the outer rim, and those proceeding from the exterior extremity of the axis reach to the inner and smaller rim. Between the rims and the crossings of the spokes is a triangular space, which is woven with a kind of close basket-work, to serve as ladle-boards, or floats. These successively receiving the current of the stream, obey its impulse, and turn round the wheel.

The buckets which take up the water are small tubes or spouts

WATER.

spouts of wood attached to the two rims of the wheel, and having an inclination of about twenty-five degrees to the horizon, or to the axis of the wheel. The tubes are closed at their outer extremities, which are fixed to the larger rim, and open at the opposite end. By this position the tubes, which in the motion of the wheel dip into the stream, have their mouths or open ends uppermost, and fill with water. As that segment of the wheel rises upwards, the mouths of the tubes attached to it will alter their relative inclination, but not so much as to let their contents flow out until such segment of the wheel arrives at the top. The mouths of these tubes are then relatively depressed, and they pour the water into a wide trough placed on pivots, from whence it is conveyed, as may be wanted, among the plantations of canes.

The only materials employed in the construction of this water-wheel, except the nave or axis, and the posts on which it rests, are afforded by the bamboo. The rims, the spokes, the ladle-boards or floats, and the tubes or spouts, or even the cords, are made of entire lengths, or single joints, or large pieces, or thin slices, of the bamboo. Neither nails, nor pins, nor screws, nor any kind of metal, enter into its construction: the parts are bound together firmly by cordage of slit bamboo. Thus, at a very trifling expence, is constructed a machine, which, without labour or attendance, will furnish, from a considerable depth, a reservoir with a constant supply of water, adequate to every agricultural purpose.

These wheels are from twenty to forty feet in diameter, according to the height of the bank, and consequent elevation to which the water is to be raised. A wheel of thirty feet is capable of sustaining with ease twenty tubes or spouts, of the length of four feet, and diameter of two inches in the clear. The contents of such a tube would be equal to six-tenths of a gallon, and the twenty tubes would hold twelve gallons. A stream of a moderate velocity would be sufficient to turn the wheel at the rate of four revolutions in one minute, by which would be lifted forty-eight gallons of water in that short period; or in one hour, two thousand eight hundred and eighty gallons; and sixty-nine thousand one hundred and twenty gallons, or upwards of three hundred tons in a day. This wheel is thought by Sir George to exceed, in most respects, any machine yet in use for similar purposes. The Persian wheel, with loose buckets suspended to the edge of the rim or fellics of the wheel, so common in the south of France, and in the Tyrol, approaches nearest to the Chinese wheel, but is vastly more expensive, and less simple in its construction, as well as less ingenious in the contrivance. In the Tyrol there are also bucket-wheels for lifting water in a circumference of wood, hollowed into scoops; but they are much inferior either to the Persian or Chinese wheel.

Chain of Buckets.—This machine consists of a number of buckets attached to a chain or rope, the ends of which are united together. The chain is conducted over a wheel, which is turned by some animal or mechanical power; and the chain hangs down from this wheel into the well from which the water is to be drawn. The buckets at the lower part of the chain become filled, and, by the motion of the chain, the buckets attached to one part of the chain will ascend full of water, whilst those on the opposite side are descending empty, with their mouths downwards. When the full buckets of water turn over the upper wheel, they discharge their contents into a trough fixed near the wheel. The most convenient way of discharging the water is to make the upper wheel hollow, with divisions in it like the tympanum; and the buckets, when they turn over, will

pour their contents into the hollow segments of the wheel, and it will run off through a hollow in the axis made for that purpose. The advantage of the chain of buckets over the wheel is, that the chain can be made to descend in a well, or small space, where the wheel could not; also, that the chain may be used for greater depths than would be practicable for a wheel.

The *Spanish noira* is a chain of buckets or earthen jars.

Mr. Townsend informs us, in his journey through Spain, that the noira consists of an endless band or girdle, passing over a sprocket-wheel: the band is long enough to reach eighteen inches or two feet below the surface of water in a well. All round this band, at the distance of about fifteen inches, are fixed jars of earthen-ware, which, as the band turns, take up water from the well, and pour it into a cistern fitted to receive it. A little ass, going round in a circular walk with ease, turns a trundle, which gives motion to a cog-wheel, fixed on the same axis with the sprocket-wheel, on which the band is hung, and with which it turns. This machine produces a constant and considerable supply of water, at a small expence, and with very little friction. As the air would obstruct the entrance of water into these earthen jars or bottles, each jar has a little orifice in its bottom, through which the air escapes; but then water runs out also, and a certain quantity falls back into the well.

It is true, as the jars rise in one straight line, the water which runs out of the superior jar is caught by that which is immediately below it, yet still there is a loss; and, besides this inconvenience, the whole quantity is raised higher than the upper reservoir, at least by the diameter of the sprocket-wheel, because it is only in their descent that the jars are emptied.

The *screw of Archimedes* is a machine on a principle very closely allied to the horn-wheel; but the curved channels are wrapped spiralwise round an axis, which is placed on an inclined position, with the lower end immersed in the water which is to be raised, and the upper end placed over the edge of the reservoir into which the water is to be delivered. When this cylinder is turned round, it will take water up in its spiral channel, and raise it gradually to the elevated end, and discharge it into the reservoir. (See SCREW.) Although this machine is simple in its general manner of operation, its theory is attended with some difficulties.

If we conceive that a flexible tube is rolled regularly about a cylinder, from one end to another, this tube or canal will form a screw or spiral, of which we suppose the intervals of the spires or threads to be equal to one another. Suppose this cylinder placed with its axis in a vertical position, if we put in at the upper end of the spiral tube a small ball of heavy matter, which may move freely, it is certain that it will follow all the turnings of the screw from the top to the bottom of the cylinder, descending always as it would have done, had it fallen in a right line along the axis of the cylinder; only it will occupy more time in running through the spiral.

If we suppose the cylinder placed with its axis horizontally, and we again put the ball into one opening of the canal, it will descend, following the direction of the first demi-spire, until it arrives at the lowest point in this portion of the tube, and then it will stop: for the weight of the ball has no other tendency than to make it descend in the demi-spire. The oblique position of the tube, with respect to the horizon, causes the ball, in descending, to advance from that extremity of the cylinder whence it commenced its motion to the other extremity. When the ball is arrived at the bottom of the first demi-spire, if we cause the cylinder to turn on its axis, without changing the position

of that axis, and in such manner that the lowest point of the demi-spire on which the ball presses becomes elevated, then the ball falls necessarily from this point upon that which succeeds, and becomes lowest; and as this second point is more advanced towards the second extremity of the cylinder than the former one, the ball will be advanced towards that extremity by this new descent, and so on, that it will at length arrive at the second extremity. Moreover, the ball, by constantly following its tendency to descend, has advanced through a right line, parallel and equal to the axis of the cylinder; and this distance is horizontal, because the sides of the cylinder were placed horizontally.

But suppose the cylinder had been placed oblique to the horizon, and turned on its axis continually in the same direction, it is easy to see that the ball will move from the lower end of the spiral tube towards the upper end, although it is actuated solely by gravity, for this causes it to occupy the lowest point of the first demi-spire; and when it is abandoned by this point, as it is elevated by the rotation, and will roll by its weight upon that point which has taken its place, this succeeding point is further advanced towards the elevated extremity of the cylinder than that which the ball occupied just before; consequently the ball, while following its tendency to descend, will be always more and more elevated, by virtue of the rotation of the cylinder. Thus it will, after a certain number of turns, be advanced from the lower extremity to the upper, or through the whole length of the spiral; but it will only be raised through the vertical height, determined by the obliquity of the position of the cylinder.

Instead of the ball, let us now consider water as entering by the lower extremity of the spiral canal, when immersed in a reservoir. This water descends at first in the canal solely by its gravity; but the cylinder being turned, the water moves on in the canal to occupy the lowest place, and thus, by the continual rotation, is made to advance further and further in the spiral, till at length it is raised to the upper extremity of the spiral, where it is expelled. There is, however, an essential difference between the water and the ball; for the water, by reason of its fluidity, will adapt itself to the form of the spiral, and, after having descended by its heaviness to the lowest point of the demi-spire, will rise up on the contrary side to the original level; on which account, more than half one of the spires may be filled with the fluid.

The most simple method of tracing a screw or a helix upon a cylinder is well known to be this:—Take the height or length of a cylinder for the perpendicular leg of a right-angled triangle, and make the base or horizontal leg equal to as many times the circumference of the cylinder as the screw is to make convolutions about the cylinder itself; then draw the hypotenuse to complete the triangle. Suppose this triangle to be enveloped about the surface of the solid cylinder, the perpendicular leg being made to lie parallel to the axis of the cylinder, and the horizontal leg or base to fold upon the circumference of the cylinder, even with its base; then the hypotenuse or sloping side of the triangle will form the contour of the screw. If a tube be formed according to the direction of this spiral, and a small ball put into it when the cylinder is placed upright, the ball would roll to the bottom with the same velocity, and the same force, as it would have descended upon a plane surface, inclined in the same degree as the hypotenuse of the triangle which we have supposed, when the base thereof is horizontal. But suppose the cylinder be inclined in such degree, that the hypotenuse of the said triangle would be horizontal instead of the base, as the angle which the

threads of the screw make constantly with the base of the cylinder is just equal to that inclination, the threads at their point of smallest inclination will be parallel to the horizon; so that there being nothing to occasion the ball to roll towards either end, it will remain immovable, supporting the cylinder to be at rest; but if the cylinder be turned on its axis in one direction, the ball (abstracting from friction) will move the contrary way, in conformity with the first law of motion. The inclination which we have just assigned is the least we can give, so that the ball shall not descend of itself; but if we augment this inclination, then, by turning the cylinder, the ball will always have a descent on one side, and will in consequence roll towards the elevated end of the same, and will mount by descending. The reason is very simple: the plane which carries it makes it rise more, in consequence of the rotatory motion, than it descends by virtue of the force of gravity. It is obvious, from what has been remarked, that this screw can never raise water, when the angle which the central line of the spiral makes with the base of the cylinder is larger than the angle which the base of the cylinder makes with the horizon.

The ratio of the weight of the ball to the force which is necessary to make it rise by turning the screw, is as the vertical space through which the weight is raised to the space passed through by the power in moving it. Suppose the moving force acts at the circumference of the cylinder, the space passed over by that force will be equal to as many times the circumference of the cylinder as the number of convolutions of the helix. Let the diameter of the cylinder be 14 inches, the vertical altitude of the upper end of the cylinder above the lower end 12 feet, or 144 inches, and 12 convolutions of the spiral: let the cylinder be so placed, that the inclination of the axis is greater than the inclination of the spiral to the axis, and let the weight to be raised be a 48 lb. ball. The circumference of the cylinder will be nearly 44 inches, and the 12 turns equal to $12 \times 44 = 528$ inches, for the space the power must move through. Hence we have 528 inches : 144 inches :: 48 lbs. : $13\frac{2}{3}$ lbs.; the measure of the requisite force to be applied at the surface of the cylinder. If the moving force describes a circle whose diameter is three times that of the cylinder, or acts at a winch whose distance from the axis of motion is 21 inches, that force will then be reduced to $\frac{1}{3}$ of $13\frac{2}{3}$ or $4\frac{2}{3}$ lbs. which is less than one-tenth of the weight of the ball. In this investigation, no notice is taken of the friction upon the pivots, or of the effects of the air included in the spiral: yet if the spiral had been folded upon a cone instead of a cylinder, or if it had been formed of a flexible tube of varying diameter, these effects would have been important: some of them are considered in our account of the spiral pump.

The Archimedes' screw is a machine so frequently employed in hydraulic architecture, as to deserve particular directions for constructing it. The simple pipe wrapped round a cylinder will not afford any considerable supply of water, and therefore a hollow barrel must be made with one or two spiral partitions running in it, like the spiral stair cases used in church steeples.

Vitruvius has given minute directions for the construction of the water-screw, and Mr. Smeaton's directions, which are very similar, are as follow:—For a screw of 18 inches diameter, use a solid cylinder of six inches diameter as an axis, upon the surface of which cut a double helix, forming two separate grooves round the axis of about three-quarters of an inch wide and deep, so that the grooves in going once round will advance about sixteen inches, and in consequence

consequence the two grooves will be eight inches apart from middle to middle, measuring parallel to the length of the cylinder. Into these grooves drive and fasten pieces of board, so as to form radii or sectors of a circle of eighteen inches and a half diameter, and so moulded as to be a little upon the twist, to answer the different inclinations of the helix, at the different distances from the centre. These pieces being jointed together, and to the axis, so as to fill the whole groove from one end of the axis to the other, form a double screw; then apply narrow boards longitudinally, reaching from one end of the screw to the other. The boards should be about four inches broad, and formed concave within, answerable to a circle of eighteen inches diameter. These boards are marked one by one at the places where they touch the spiral boards, and are then grooved about a quarter of an inch, to admit the ends of the radius pieces which form the screw. When all the boards are put together they form a cylinder of eighteen inches diameter, which is hooped on the outside, in the manner of a tub or cask; and in order that the hoops may properly drive on the outside, at the same time that the inside forms a complete cylinder, the longitudinal pieces are made rather thicker in the middle than at the ends.

Archimedes' screw may be used for other purposes than raising of water. It might be adapted with advantage in raising cannon-balls from a ship to a wharf, and with the addition of a bevel-wheel or two and their pinions, might be worked either by men or horses. Sometimes Archimedes' screw instead of being worked by men at a winch, is turned by means of float-boards fixed on the circumference of a wheel placed at its lower end, upon which a stream of water acts. If the water has a moderate fall, it will have sufficient efficacy to turn two screws, one above another. The top of the lower screw and the bottom of the upper screw may act one upon the other, by means of a wheel upon each, with an equal number of teeth taking into each other. In this case the upper screw will turn in a contrary direction from the lower, and consequently the spiral tube must be wound about the cylinder in an opposite direction. A solid wheel, or a light wheel with a heavy rim, turning upon the middle of the screw as an axis, will operate like a fly, and in some cases be very useful.

Mr. Smeaton made a machine to raise water by an Archimedes' screw for the royal gardens at Kew, which was on a large scale. The screw was twenty-four feet long, two feet six inches in diameter, and raised the water perpendicularly fourteen feet nine inches. The central cylinder, or shaft of the screw, was ten inches diameter; the distance between the threads, including the thickness of the helix, was twelve inches and a half; and as there were two spiral passages, each spiral advanced twenty-five inches along the cylinder at every turn; each spiral contained twenty-seven quarts at every turn, the screw therefore gave out fifty-four quarts at every turn which it made.

This screw was turned by means of a trundle or pinion from a horse-wheel, with the intervention of two moveable joints, to change the direction of the axis from the horizontal to the direction of the axis of the screw, which was inclined at an angle of about thirty-eight degrees to the horizon. The diameter of the horse-track was twenty-five feet, half of which was the length of the effective lever upon which the horses acted. The great cog-wheel on the axis of the levers was fourteen feet diameter, with 144 cogs, and the trundle which it turned twenty-three cogs, so that the screw made about six turns for one of the horse-wheel.

This machine was worked by two light horses, with very

great ease, and they made three turns *per* minute; but if at all urged, could make the screw turn twenty turns *per* minute, and at that rate of working raised 300 hogheads *per* hour.

The *Water-screw*, described in our article SCREW, does not differ from the screw of Archimedes in its principle, but as the screw turns round within a fixed barrel, the water is liable to leak back in part.

Drawing Water by Buckets.—The methods which we have hitherto described are only adapted to raise water to small elevations; but by means of buckets, water may be drawn from very great depths. The most simple case is that of a man with a bucket or other vessel in his hand, stooping down to lower the empty bucket into a pond, as low as he can reach, and drawing it up full of water.

The first improvement which would occur would be to suspend the bucket by a rope, and draw it up by means of a long lever, or otherwise, if the depth was greater, by continuing the rope over a pulley, so that the man could easily draw the end of it; and this would be farther improved when two buckets were suspended at the opposite ends of the rope or chain, so that one being drawn up full of water, an empty one would be let down at the same time. This method is applicable to the deepest well, and is very effective. The addition of a windlass and crank would be a successive improvement, and could be made to act either singly, to draw up one bucket, or double, to let down an empty bucket at the same time it drew up another loaded with water.

The drawing up of a bucket by a rope and pulley is so simple and obvious as to need no explanation. The bucket should be of such a size that it will not weigh above twenty-six pounds, and will therefore contain nearly half a cubic foot of water. For although a man could with ease raise a much greater weight, yet he would be unable to draw it up so quickly, or to work at it throughout the day; and what he would gain by the increased quantity of water, he would lose in the time which it would require to draw up the bucket, and in the time he would require to rest himself from his fatigue. If the rope is conducted horizontally, and the man takes it over his shoulder and walks along the ground, his force will be applied in a much more effective manner than by simply hauling the rope over a pulley; and a horse may be applied in the same manner with a larger bucket, and there is perhaps no better mode of applying the force of a horse for a deep well. The bucket should not in this case weigh above a hundred and twenty pounds, or it must not contain above two cubic feet to enable the horse to draw it with that velocity which is most natural to him.

When a windlass is employed to wind up the rope, the winch or crank, which is applied to the axis of it, can be made much larger than the radius of the windlass, and in consequence the power may be increased so much that a larger bucket may be drawn, which is some advantage, because less time will be lost in stopping to fill and empty the bucket, otherwise nothing is gained in drawing up a large bucket, because it must move slower in proportion to its increased weight; but in all cases the length of the handle should be about fourteen or sixteen inches, to enable a man to turn it with ease, and the weight of the bucket must be so adapted to the size of the windlass, that the power required at the handle will not be above thirty pounds or even twenty-five pounds, if a man is to work continually for six or eight hours in a day. For example, suppose the bucket is about forty-six pounds weight, and the handle sixteen inches long, then as 46 is to 25, so is 16 to $8\frac{3}{4}$ nearly; from

which deduct half the thickness of the rope, and it leaves the proper radius for the roller or windlafs. A rope of the proper size for this purpose will be about two inches and a half in circumference, or rather more than three-quarters of an inch in diameter; hence the diameter of the barrel will be $16\frac{3}{4}$. If a fly-wheel is applied to the axis, it will be an advantage to equalize the force which the man applies, because some positions of a crank or handle are less favourable than others for the exertion of a man's strength. It is most advantageous to employ two buckets, and as the rope for one unwinds whilst the other winds up, the weight of the two buckets balance each other, and the man has only the weight of the water to draw up.

Bucket-Machines for deep Wells.—When a machine to draw water by buckets is made on a larger scale, the windlafs is placed perpendicularly, and levers applied to it at the lower end, which may be actuated either by men, or by horses walking round in a circle on the ground, and drawing or pushing the end of the lever; in this way a powerful machine may be made, and if the depth is very considerable, it is a very good method. Many methods have been proposed to make the buckets fill themselves when at the bottom of the well, and empty when at the top: the best is to suspend the bucket in an iron loop or bow, like the handle of a pail, but this should be made so long, that the pins on which the cask or bucket hangs, shall be but little above the centre of gravity of the bucket when loaded with water; in consequence, when the bucket is drawn up to the top, one edge of it is caught by a hook fixed on the edge of the cistern into which the water is to be delivered, and the bucket still continuing to be drawn up whilst the hook detains one edge, the bucket is thereby overturned, and its contents discharged into the reservoir. It is requisite for this plan, that the bucket be made, by some contrivance, to prevent itself always in the same direction to the hook, so that it will be seized and overturned thereby: one method is to fix upright pieces of wood or iron in the well on each side of the bucket, and the pivots on which the bucket is poised project on each side beyond the iron loop on which the bucket hangs, and enter into grooves formed in these pieces, so as to be guided in the ascent and descent of the bucket. Another method is to make the rope of the bucket double for some feet immediately above the bucket, that is, the rope divides into two ends, each of which is made fast to the opposite side of the iron loop in which the bucket is suspended: the rope is made to pass through a narrow opening in a piece of plank, which will admit the double rope to pass freely, provided the bucket comes up in the required position; but if it does not, then the forked rope will be acted upon by the sides of this narrow opening in such manner, as to turn the bucket round to the required position.

To make the bucket fill readily at the bottom of the well, a simple valve is made in the bottom, which opens upwards and admits the water, but shuts when the bucket is drawn up out of the water. In the Transactions of the Society of Arts, vol. xii. is a description of a machine by Mr. Ruffel, in which the bucket, when it is drawn up to the top of the well, acts upon a lever, and causes a moveable trough to run across the well beneath the bucket; and then as the bucket rises higher, a trigger, which belongs to the valve in the bottom of the bucket, is intercepted by a fixed piece of wood, so as to open the valve, and the water runs out of the bucket into the moveable trough which conveys it into the reservoir: when the bucket begins to descend, it allows the levers to return, and the moveable trough retreats from beneath the bucket, and allows it to descend again into the well to bring up a fresh charge. The moveable trough is made

to run backwards or forwards over the mouth of the well, by means of wheels or rollers, on which it is supported, and these wheels run upon pieces of wood laid across the well.

Indian Method of drawing Water by a leathern Bucket.—Dr. Roxburgh of Calcutta has given us a description of a method of raising a large quantity of water from a deep well by means of one or two buffaloes or bullocks, which is in common use in many parts of Hindoostan, where the wells are too deep for the lever. A pulley is erected over the well to receive a rope, which the animals draw by walking along an horizontal path in order to elevate a large bucket, and they return towards the well to lower it down: the bucket is made of leather, like a long funnel, extended at the top or mouth by a square frame of wood, or by a hoop, and the lower end terminates in a small open tube, which is flexible, and can be turned up; in which case, if the orifice of the tube is kept as high or higher than the mouth of the bucket, no water can escape through the tube, it is in this condition that the bucket is drawn up full of water: the end of the tube has a cord fastened to it, which is conducted over a roller fixed on the edge of the trough into which it is desired to deliver the water, and which trough must be at least the length of the bucket beneath the great pulley that is fixed over the well. The opposite end of the cord is tied to the great rope near the point where the buffaloes draw, and the cord is of such length as to hold the orifice of the tube rather above the mouth of the bucket, until the tube is drawn up to the roller. When the cord draws the tube over the roller, and leads its end into the trough as the bucket continues to be drawn up, it is raised above the level of the trough, by which means the whole of the water will make its escape through the orifice of the tube into the trough: when the bucket is let down again, the flexible tube returns over the roller, and the cord holds up its orifice above the top of the bucket.

Defaguliers, in the second volume of Experimental Philosophy, describes a very simple contrivance to raise water by a bucket; which is this, to one end of a rope is fixed a large bucket, having a valve in its bottom opening upwards; to the other end of the same rope is fastened a square board, something like the scale-board of a balance, but large enough for a man to stand upright in it; the cord is made to pass over two pulleys, each of about fifteen inches diameter, and fixed in such manner, that as the bucket descends, the scale ascends with equal velocity, and *vice versa*. The scale is made to run freely between four vertical guide rods, passing through holes at its four corners, and when the bucket is lowered down into the lower water-cistern in order to fill with water, the scale stands nearly level with the horizontal plane of the upper reservoir to which the water is to be raised. When the bucket is full, a man steps into the scale, and his weight, together with that of the frame, exceeding the weight of the vessel and its contained water, will give an ascending motion to the bucket, and causes the valve in its bottom to close. When the bucket is raised to the proper height, a hook which is fixed at the edge of the upper reservoir catches into a halsp at the side of the bucket, and turns it over, to cause it to empty its water into the upper cistern, or into a trough, which conveys it where it is required: at this time the man and the scale have arrived at a platform, which prevents their further descent, and the man must remain in the scale till he finds the bucket above is empty, when he steps from the scale, and runs up a flight of stairs to the place from which he descended: the bucket in the mean while, being somewhat heavier than the scale, descends again to the water, and raises the frame to its original position; thus the work is

is continued, the man being at rest during its descent, and labouring in the ascent.

Defaguliers employed in this kind of work a tavern-drawer, who had been used to run up and down stairs; he weighed 160 pounds, and was desired to go up and down 39 steps of $6\frac{1}{2}$ inches each (in all about 21 feet) at the same rate he would go up and down all day. He went up and down twice in a minute, so that allowing the bucket, with a quarter of a hoghead of water in it, to weigh 140 pounds, he is able to raise it up through 21 feet twice in a minute, which is equivalent to the whole hoghead raised $10\frac{1}{2}$ feet in a minute, and rather exceeds what Defaguliers assigned as a maximum of human exertion; from experiments made with a mercurial pump. He recommends that the man in the scale should weigh one-fifth or one-sixth more than the weight of the water in the bucket, in order to give him a preponderance to bring up the bucket with a proper velocity.

Balance Buckets.—This is an ingenious contrivance for raising water by the power of a small fall of water: suppose a wooden lever twenty feet long, poised upon a centre at five feet from one end, one arm will then be five feet long, and the other fifteen, or three times. At the extremity of the long arm a small bucket is fixed, and at the extremity of the short arm another bucket, which is rather more than three times as great in capacity: the lever is so poised, that it will place itself in an horizontal position when both the buckets are empty; but suppose that in this situation a small spout of water runs into each bucket, when they become both filled, the larger bucket at the end of the short arm will overweigh the smaller one, because it holds more than three times as much water; in consequence, the larger bucket will descend and move the lever into a perpendicular situation, by which means the small bucket is raised fifteen feet above the level of the spout at which it received the water, whilst the great bucket has descended five feet beneath its source of supply. Both the buckets are suspended to the ends of the lever on pivots, so that they can readily be turned over to discharge their contents; this takes place when the lever arrives near its vertical position: the small bucket is caught by a hook, and overturned into the elevated trough which is to receive the water, and immediately the lower bucket is emptied by similar means. The long end of the lever is now the heaviest, and in consequence the lever returns to its horizontal position, in which it remains until the buckets are both full, and then it makes another stroke. A simple contrivance is applied to stop the running of the spout of water during the time that the lever is in motion, to prevent waste of the water.

The *losing and gaining Buckets* is a similar machine to the preceding, but admits of raising the water to a greater height, because chains and wheel-work are employed instead of a lever. This machine will raise water sufficient to serve a gentleman's seat, with an overplus for fountains, fish-ponds, &c. A machine of this kind can be erected wherever there is a spring affording a small supply of water, and having even so small a fall as ten feet. It is possible, by this invention, with the loss of part of the water, to raise the rest, to supply a house, or any place where it is required; but, of course, it must be in a less quantity than the fall of water which is to actuate the machine, nearly in the same proportion as the place to which the water is to be raised is higher than the fall of the spring. For example, the fall of one hoghead through ten feet will raise about one-sixth of a hoghead to the height of forty feet. This machine had been conceived by Schottus a great many years ago, and he gave a draught of it. It is described in Leopold's *Theatrum Machinarum Hydraulicarum*, 1720; but it was never

put in execution to any good purpose in England, till Mr. George Greaves, a carpenter, erected an engine upon this principle, about 1730, for Sir John Chester, baronet, at his seat at Chickley, in Buckinghamshire; a sketch of which is given at *fig. 13, Plate Water-Works*. A small spring of water, supplying four gallons *per* minute, is conveyed seventy-two yards, by a gutter, into a cistern N, containing about twelve gallons. This water has a descent to the other cistern at R, ten feet below X; from the latter, the waste is conveyed off along H, by a drain or sewer. The descent of part of the water through this ten feet is the motive force to work the machine. A, B, are two copper pans, or buckets, of unequal weights and sizes, suspended by chains, which alternately wind off, and on the two multiplying-wheels Y and Z, whereof the wheel Y is smaller in diameter, and Z larger, in proportion to the different lifts each bucket is designed to perform. A house is built over the well or cistern, with three floors, for the conveniency of fixing the parts of the engine. On the uppermost floor is fixed a frame of timber 2 2, in which the moving parts are supported, as is shewn, (part being broken off in the figure, to explain the work): across this frame lies an horizontal axis G, three feet and a half long, moving on two gudgeons in brasses. Upon this axis are framed three wheels; first, the small wheel Y, which is two feet diameter, and shrouded, or made with a raised rim at each side: the edge of the wheel is five inches broad, and shod with iron. Upon the wheel Y is fixed a chain, made very flat and flexible, which, after it has wrapped once round the wheel, is then made double, that it may lie on each side of the edge part, the double parts having a sufficient opening between them to admit the single part, and this prevents fretting or galling, and keeps the chain exactly perpendicular: from the extremity of the double part is hung a long rod of iron, at the bottom of which the great bucket A is fixed. The largest wheel Z on the axis is six feet diameter, and one inch and a half broad on the face, which is also shrouded: this wheel is not circular, but spiraled two inches, both in the sole and in the shrouds; so that its radius at the least part is two inches less than three feet. Upon the large wheel Z is fixed a smaller chain, to suspend the bucket B: it is made like the former, and so arranged, that when the wheel Z has made one revolution from left to right, the spiral sole will take up a certain length of the chain. After this length, the lower or remaining part of the chain has cross-bars fixed to it, at equal distances, which fall upon the edges of the shrouds into notches plated with iron: by this means, and by the help of the spiral, this part of the chain is not only prevented from riding upon the other, but helps to equiponderate the increase of weight of the other chain of the bucket A. A third wheel *r*, three feet ten inches diameter, is fixed on the axis G, between the other two wheels: it is shrouded like the others, and is spiraled three-fourths of an inch; it receives a rope, the lower end of which goes about a wheel *d*, of two feet diameter, to which that end is fixed, and on the axis, *d*, of this wheel is another, *t*, one foot diameter, and to this is fastened a rope, which goes down upon the quadrant *ab*, which carries a sliding weight in a box at the extremity of the arm Q; the quadrant *a* moves on the axis *b*, and the rope descending from the wheel *t*, is guided between iron plates, upon the circumference of the quadrant. The box, at the end of the arm Q, contains a sliding lead weight, to counter-balance the weight of the chains, by keeping an exact equilibrium in every position of the machine. Besides the action of the quadrant, the motion is regulated by wheel-work, like that of a jack; thus, upon

one end of the axis *G*, is a strong iron wheel *M*, giving motion to a pinion *m*, and by means of a wheel and worm *n* and *o*, to a fly *P*, which regulates the motion of the engine, and prevents any improper acceleration from the unwinding of the chains. The small bucket *B* is made of copper, about five gallons in capacity; it has a valve in the bottom, by which the bucket will be filled when it descends into the water of the cistern *N*. The bucket is suspended in an iron link, or handle, upon two pivots, so that it can be very easily turned over upon them. This happens when it is drawn up to *F*, the edge of the bucket catching a hook which overturns it, and discharges the contents into the trough *W*, at an elevation of thirty feet above *X*, and whence it is conveyed by pipes wherever it is wanted. The great bucket *A* is likewise made of copper, and contains about fifteen gallons when drawn up to the position *A*: it is filled with water from a valve, or sluice, in the side of the cistern *N*, which is then opened by a bent lever, whereof the end projects, so that the bucket will lift it up. In the bottom of the bucket is a spindle-valve, which is opened when the bucket has descended to *R*, by the end of its spindle resting on the bottom of the well. Iron rods are fixed vertically to guide both the buckets, which have ears with brass rollers in them, and inclose three sides of each, which is square, and they are thus caused to ascend and descend in a perpendicular line, and no other.

The operation of the machine is as follows:—When the buckets are empty, they are stopped, as shewn in the figure on a level with the spring at *X*, whence they are both filled with water at the same time, in the manner just described.

The greater of the two *A*, being the heavier, when full preponderates, and descends ten feet from *C* and *D*, and the lesser *B*, depending from the same axis, is at the same time weighed up or raised from *B* to *F* thirty feet.

Here, by catching the hook *F*, the small bucket discharges its water into the trough *W*, and thus suddenly losing weight, it lets the great bucket down an inch lower, and the valve in the bottom is opened, so as to let out its water, which runs waste by the drain below at *H*. The bucket *B* being then empty, is so adjusted as to overweigh, and descending steadily as it rose, betwixt the guiding-rods, it brings or weighs up *A* to its former level at *X*, where both being again replenished from the spring, they thence proceed as before. And thus will they continue constantly moving, (merely by the circumstantial difference of water and weight, and without any other assistance than that of sometimes giving the iron-work a little oil,) so long as the materials shall last, or the spring supply water.

The steadiness of the motion is, in part, regulated by the fly *P*, which not only keeps the engine to an equal velocity, but by its running forwards, after the buckets are quite up or down, holds them steady till they are completely filled or emptied, and prevents them recoiling back too soon. In order to counterbalance the weight of the chains in every position, the wheels *r*, *d*, and *t*, are so calculated, that during the whole performance up and down, they let the quadrant *a* move no more than one-fourth of a circle; by which contrivance, as more or less of the chains which suspend the buckets come to be wound off their respective wheels *Y* and *Z*, this weight gradually increases its action as a counterbalance, and so continues the motion equable and easy in all its parts. The spiraling of the wheels *Y* and *Z* help, in some measure, to regulate the weight of the chains in every position, as they act in winding on and off the wheels; but the quadrant *ab*, and lever with the weight *Q*, complete the equilibrium, by acting with the greatest force, because the lever is in the horizontal position

when the chain of the great bucket *A* is all down, and weighing upon the wheel, the weight *Q* then acts with its whole weight upon the wheel *t*, as that chain is drawn up, its acting weight is thereby diminished, and the lever of the weight *Q* is moving down towards its perpendicular, whereby the weight *Q* diminishes equally in its influence on the motion of the wheel *r*, until it hangs perpendicular, and its weight ceases to act; but the sliding-weight then runs down in its box, to keep the rope tight, the sliding-weight being attached to the end of the rope, and not to the lever. At the first return, or re-ascent of the great bucket, the weight *Q* is drawn up to a shoulder, before any motion is given to the lever of the quadrant; but whilst the long chain of the small bucket evolves from its wheel *Z*, the acting-weight of the quadrant is continually increasing, and at the same time the other chain of the great bucket wrapping itself upon the wheel *Y*, its acting weight is decreasing. The lever of the quadrant rising higher, brings the line of direction of the weight *Q* farther from the centre of the quadrant, and so lays a greater force or obstruction to retard the wheel *r*, and continually keeps a counterbalance.

This engine, at a slow motion, carries up one bucket full in five minutes; but if the spring ran double the quantity, it would go up twice in the same time, and an engine of this kind may be made to raise one hoghead *per* minute, or more, if required, the consumption of water is less than what is spent by a water-wheel to raise an equal quantity of water to the same height.

The Endless Rope to raise Water.—This is a most simple contrivance, and will raise up a small quantity of water from a very considerable depth. A soft hemp or hair-rope, with the ends spliced together, is suspended over a large wheel, which is turned by a handle; the rope must hang down into the well, and reach some depth into the water, and a similar wheel may be placed beneath the surface of the water for the rope to pass under; but this is not necessary when the length of the rope is such, that its own weight will make it apply close to the upper wheel. The upper part of the rope must descend through a tube, which is fixed in the bottom of the cistern, or reservoir, to prevent the water running down with the rope; the tube is of such size as to fit the rope very nearly, but not to cause any considerable friction. The rope is put in motion by turning the handle of the wheel, and the motion must be in such a direction, that the rope where it passes through the tube in the cistern shall descend.

The consequence is, that the water in the well adheres to the rope, and surrounds it like a film, or covering of water; but when the rope passes over the wheel, some of the water is thrown off by the centrifugal force, and falls into the reservoir, and that part of the water which escapes the action of the wheel is separated from the rope by the tube through which the rope passes; for it is to be observed, that the film of water which surrounds the rope is put in motion, whilst it is in the well, by the lateral adherence of the water to the rope, which motion being continually kept up, is sufficient to overcome the gravity of the water; but if any body is presented to the rope, so as to resist the motion of the water, without obstructing the motion of the rope, the water will fly off, and, losing its motion, will obey the action of gravity, and fall down.

The velocity with which the rope requires to be moved, will depend upon the depth from which the water is to be raised. The length of that part of the rope which is immersed in the water is also of some consequence, for it must be such, that the rope will act upon the still water which

which immediately furrounds it, until it has put that water in motion with nearly the same rapidity as the rope, and then such portion of water will accompany the rope; but this cannot take place without communicating a slower motion to a much larger quantity of water, which will also accompany the rope with a slower motion; but being too far removed from the rope to have its motion accelerated, or even maintained, its velocity will continually decrease, until it ceases to ascend, and then it will begin to run back. But this is to be understood only of that part of the water which is too far distant from the rope to have its motion fully maintained by the lateral action of that water which is nearer to the rope, and which moves with nearly the same velocity as the rope. If the rope is examined at the point where it rises above the surface of the water, it will be found to be surrounded by a column of water which is of a considerable size at the base, but diminishes as it rises upwards, somewhat in the form of a trumpet, so that at a few feet in height it is but little larger than the rope. This column of water is composed of several laminæ, each moving with a different velocity: for instance, the interior part moves nearly as quick as the rope, the water which is more distant from the rope moves slower, until there must be a part in which the water remains immovable, and all the water which is beyond this, and on the outside of the column, runs downwards, and falls back into the well. On this account, the machine loses a considerable part of the power which is applied to it without producing an adequate effect.

This machine was invented by the *Seur Vera*, in France. A machine was made by him with a wheel three feet diameter, and a hair-rope of half an inch diameter, the well was ninety-five feet deep. A man could turn the wheel sixty times *per minute*, which gives a velocity of five hundred and fifty-five feet *per minute* for the rope. It brought up six gallons *per minute*, but was severe labour for one man. When the wheel made fifty turns, and the rope moved four hundred and seventy-one feet *per minute*, the machine still raised a considerable quantity of water; but if the motion was reduced to thirty turns, or two hundred and eighty-two feet *per minute*, it brought up scarcely any water. A rope of hair is preferable to hemp, because it is less subject to decay; and when a hemp-rope begins to rot, it communicates a taint to the water.

The *Sucking-Pump* has a valve at the bottom of the barrel, and also another valve in the piston, which is called a bucket, because it brings up the water before it. This pump does not raise water when the bucket is let down, but only when it is drawn up, which is in some cases an inconvenience; and another objection is, that it cannot raise water to a greater height than the place where the power is applied, because there must be an opening for the pump-rod to come out at, and the water would flow out at the same opening, if it was raised as high. This inconvenience is remedied by

The *Lift-Pump*, which has a valve in the bucket, the same as the sucking-pump, but it differs from it in the manner of communicating the force to the piston or bucket: one way of effecting this is to make the barrel open at the lower end, and the rod from the bucket, instead of being fixed to the upper side of the bucket, is fixed to the lower side, and comes out beneath the surface of the water in which the barrel is immersed. Rods are jointed to this, and rise up parallel to the barrel, in order to be attached to the lever by which the pump is to be worked: the fixed valve is placed at the top of the barrel above the bucket: this is the old-fashioned lift-pump.

The *Lift-Pump with a Stuffing-box*, called sometimes a jack-head pump, is exactly the same as the sucking-pump, except that the top of the barrel is covered by a lid, which has a hole in the centre for the rod to pass through: the rod is made very smooth and true, and the hole is so formed as to contain collars of leather, which fit close round the rod, and prevent the escape of any water by the side of the rod. The water mounts up a pipe which communicates sideways with the upper part of the barrel.

Another form of lift-pump has been recently introduced, in which the piston is solid, having no valve in it, and the rod passes through a stuffing-box or collar of leather in the top of the barrel, the bottom of the barrel being open. Two pipes are made to communicate sideways with the barrel at the upper part, one of which brings water from the well into the pump when the piston descends, and has a valve in it to prevent the return of the water; the other pipe conveys the water away from the barrel when the piston is drawn upwards, and this is likewise furnished with a valve to prevent the return of the water.

One advantage of this kind of pump is, that both valves are situated in boxes near the top of the barrel, and can be examined and repaired at any time by taking off the doors or covers of the boxes; but in pumps where there is a valve at the bottom of the barrel, it sometimes happens that the valve fails, and requires to be repaired, when the water in the well stands higher than the cover or door of entry to the valve: in this case, some other means must be used to reduce the water in the well, or else the pump must be drawn up out of its place, which, in large works, is very difficult. Another advantage is, that the apertures of the valves may be made of any required dimensions to let the water pass freely through them; but when the water must come up through a valve in the bucket or piston, the passage through the valve must necessarily be much smaller than the barrel, to allow a proper lodgment all round for the valve and also for the leathers.

The *Force-Pump*.—This is made with a solid piston, like the last, but the barrel is open at the top, where the piston-rod comes out. There is a valve at the bottom of the barrel to admit the water into it, and a pipe, which turns sideways out of the barrel at bottom, and has a valve to prevent the water returning into the barrel, to convey the water to whatever place it is to be forced to. The force-pump raises water only when the piston is pressed down, whereas the lift-pumps and sucking-pumps raise the water when the buckets are drawn up.

The *Lift and Force-Pump of M. De la Hire*.—This is the union of the two last pumps in one, for both these pumps work with a solid piston, and the barrel of the force-pump is open at top, and the barrel of the lift-pump is open at bottom; hence the same barrel and piston may be made to serve for both. This pump throws up water equally when the piston-rod is drawn up or when it is forced down, and is most proper for the double-acting steam-engine. It has the advantage of raising twice the quantity of water that any of the other pumps will raise, and with the friction of only one piston; also the valves admit of being made of sufficient size to allow the passage of the water without any unnecessary resistance.

Force-Pump with a solid Plunger.—This was invented by *Mr Samuel Morland*, and does not differ from the force-pump last described, except in the manner of fitting the piston to the barrel. Instead of the barrel being bored truly cylindrical within, and the piston fitted into it so as to slide up and down, and provided with leathers to make a close fitting, the piston is made of a cylindrical form, and very nearly

as large as the hollow barrel into which it descends, but it does not touch the inside of the barrel. To make the close fitting, the outside surface of the cylindrical piston, or plunger, as it is called, is made very true and smooth; and it is surrounded by a collar of leathers fixed at the top of the barrel, so that no water can leak out of the barrel between the plunger and the leather collars; at the same time that the plunger can freely move up and down through the collars, and will thereby increase or diminish the capacity of the barrel, to produce the same effect as if the piston fitted close into the barrel.

The principal circumstance to be attended to in this pump is the construction of the collar of leathers. To retain these leathers in their places, the top of the barrel must be made with a flaunch, and pierced with holes to receive screw-bolts. Upon this flaunch two rings of metal are applied one over the other, with similar holes: the internal opening in the lowest ring is exactly the size of the plunger, and that of the upper one a little larger. Two rings of soft leather are cut out to correspond with the metal rings, except that the central holes are rather smaller than the plunger: to prepare the leather, it is soaked in a mixture of oil and tallow for some hours. One of these leather rings is laid on the pump-flaunch, and one of the metal rings placed above it; the plunger is then thrust down through the leather, which turns the inner edge of the leather ring downwards; the other leather ring is then slipped on at the top of the plunger, and the second metal ring is put over it, and then the whole are slid down to the metal ring; by this the inner edge of the last leather ring is turned upwards.

The metal rings and leathers are now fixed on the flaunch by the screw-bolts; and thus the leathern rings are strongly compressed between them, and make a close joint with the top of the barrel; and as the holes through the leathers are smaller than the plunger, they grasp the plunger so closely that no pressure can force the water through between them. The lower metal ring just allows the plunger to pass through it, but without any play, so that the turned-down edges of the lower leathern ring cannot come up between the plunger and the lower metal ring, but are lodged in a conical enlargement, which is made round the inner edge of the upper part of the barrel; and in like manner the turned-up edges of the upper leather are received in the hole of the upper metal ring, which hole is made larger than the plunger, to leave a space all round for these edges: it is on these trifling circumstances that the great tightness of the collar depends. To prevent the leathers from shrinking by drought, there is usually a little cistern formed round the head of the pump, and kept full of water.

This kind of pump is preferable to any other, where the pressure to be overcome is very considerable. The hydrostatic presses are constructed on this principle. See PRESS.

Pistons or Buckets for Pumps.—A good piston should be as tight as possible, and should have as little friction as is consistent with this indispensable quality. The bucket of the common sucking-pump, when carefully executed, possesses these properties in a high degree, and is the model for other kinds of pump-buckets, or pistons, in which leather can be employed. This bucket is in the form of a truncated cone, with a hollow through the centre of it, which is half as large as the outside, at the largest part; it is generally made of wood not liable to split, such as elm or beech, but in the best kind of pumps is made of metal. The small or upper end of it is cut away at the sides, so as to open into the hole through the centre of it, and form an arch, by which it is fastened to the iron rod or spear of the pump, and within the arch the valve or clack is situated. The lower end of

the conical part may be covered with a hoop of brass, which fits the barrel of the pump very exactly; the bucket is also surrounded with a ring or band of strong leather, fastened to the wood with nails, and firmly retained by the brass hoop which is driven down on the bucket from the upper or the smaller end of the cone, and binds the leather fast on the wood; but the leather being wider than the brass, the edge of the leather rises upwards and surrounds the wood: this part of the leather is made to turn outwards, like a cup or hollow cone, which, at the upper end, is rather larger than the barrel, so as to spring against the inside of the barrel when the bucket is put into it. The leather must be of uniform thickness all round, so as to suffer equal compression between the wood of the bucket and the working barrel, but this compression is very slight, because it is the upper edge of the cup which applies most closely to the barrel. The seam or joint of the two ends of the band of leather must be tapered, and made to overlap and lie very close, without increasing the thickness, but not sewed or stitched together, as that would occasion bumps or inequalities, which would spoil its tightness; and no harm can result from the want of sewing, because the two edges will be squeezed close together by the compression in the barrel; nor is it by any means necessary that this compression be great, for it occasions friction, and causes the leather to wear through very soon at the edge of the bucket, and it also wears the inside of the working barrel, which soon becomes enlarged in that part which is continually passed over by the piston, while the mouth remains of its original diameter, and then it is impossible to thrust in a piston which shall completely fill the worn part. A very moderate pressure is sufficient for rendering the pump perfectly tight, because the pressure of the water makes the leather cup apply itself close to the barrel all round, and even adjust itself to all its inequalities. Suppose it to touch the barrel in a ring of an inch broad all round, this is a trifle, and the friction occasioned by it not worth regarding; yet this small surface is sufficient to make the passage perfectly impervious, even by the pressure of a very high column of incumbent water: for let this pressure be ever so great, the pressure by which the leather is forced against the inside of the barrel will always exceed it, because, in addition to the pressure of the water, the leather will always press against the barrel by its own elasticity, the top of the cup of leather being made rather larger than the interior of the barrel.

This method of applying leather pistons is found to be preferable to any other, because if the leather is pressed against the barrel by any other means than the force of the column of water, the pressure will always be too great or too little.

Pumps which are to raise hot water cannot be leathered, because the leather would shrivel up; in this case, strong canvas cloth is sometimes used instead of leather; but as this will not hold water perfectly, such pumps are generally packed with hemp, in the same manner as the piston of steam-engines.

Pump without Friction.—When the height to which the water is to be raised is small, a pump may be constructed in which the piston does not require to be fitted closely into the barrel, nor are any leathers required. The barrel of this pump must be as long as the whole height to which the water is to be raised, and as much more as the length of the stroke of the piston. The piston is a solid piece of wood, fitted to the barrel as closely as it can be without actually touching the inside, and may be either square or round, but a square trunk and a square beam of wood are best, if the pump is made of wood. The piston must be as long as the barrel,

barrel, so that when it is let down it will occupy the whole interior space of the barrel, except that small space which is left between the inside of the barrel and the piston, to avoid actual contact. The bottom of the barrel has a valve in it which opens upwards, and a pipe proceeds from the lower part to convey away the water to the reservoir into which it is to be raised by the pump. This pipe is provided with a valve, to prevent the return of any water which has passed through it, but the greatest elevation of the water in the reservoir must not be quite so great as the top of the barrel. When this pump is fixed for work, the lower end of the barrel must be immersed in the water of the well at least as much as the whole length of the stroke, so that the lower end of the piston will never rise above the surface of the water in the well, and upon this circumstance the action of the pump depends; for when the piston is drawn up, the water flows through the valve in the bottom by its gravity, and fills the space which is left by the drawing up of the piston; when the piston descends, it displaces from the barrel all this water, and forces it up the side-pipe into the reservoir. It is true that a small portion of water rises in the space between the barrel and the piston, but this small quantity cannot escape, because the top of the barrel rises higher than the surface of the water in the reservoir.

Dr. Robinson, who we believe first described this pump, observes that it is free from all the difficulties which are experienced in common pumps, from want of being airtight. Another is, that the quantity of water raised is very nearly equal to the power expended; for if there is any want of accuracy in the work, which occasions a diminution of the quantity of water discharged, it also makes an equal diminution in the force which is necessary for pushing down the plunger. The doctor mentions a machine, consisting of two such pumps, the pistons of which were suspended from the arms of a long beam or lever, the upper side of which was formed into a walk, with a rail on each side. A man stood on one side of the centre of the lever, until the piston of the pump at that end sunk to the bottom of its barrel, and of course the piston of the pump on the opposite side of the centre was drawn up; he then walked slowly up to the other end of the walk upon the beam or lever, the inclination being about twenty-five degrees at first, but gradually diminished as he went along, and passed on the opposite side of the centre of motion, so as to change the load of the beam. By this means he made the piston at the other end go to the bottom of its barrel, and so on alternately, with the easiest of all exertions, and what a man is most fitted for by his structure. With this machine a feeble old man, weighing 110 pounds, raised 7 cubic feet of water $11\frac{1}{2}$ feet high every minute, and continued working eight or ten hours every day. A stout young man, weighing nearly 135 pounds, raised $8\frac{1}{3}$ cubic feet to the same height; and when he carried 30 pounds conveniently slung about him, he raised $9\frac{1}{4}$ feet to this height, working ten hours a day, without greatly fatiguing himself. This exceeds Desaguliers' maximum of a hoghead of water ten feet high in a minute, in the proportion of 9 to 7 nearly. This pump is limited to very moderate heights, and in such situations it is very effectual.

The *mercurial pump* is a species of lift-pump, in which mercury is employed to make a close fitting between the piston and the barrel, and thus avoid the friction of leathers, and prevent loss of water.

This pump was originally invented by Mr. Joshua Haskins, and was improved by Desaguliers, who described it in

the Philosophical Transactions for 1722, N^o 370. p. 5; and he has also given every detail of the construction in his Experimental Philosophy, vol. ii. p. 491.

In this pump the barrel is inverted, that is, it is open at the bottom, like the first lift-pump which we have mentioned; and it has also two pipes communicating with the upper end of the barrel, one to bring up the water from the well, and the other to carry it up to the reservoir: each pipe is provided with its valve, to prevent the return of the water. The barrel must be made of iron, and as thin as is consistent with the strength of the metal. The piston is a cylindrical plug of wood, fitted to the barrel so as to fill it, but not to touch the sides. This piston is fixed perpendicularly in the centre of a hollow cylinder of iron, which is rather larger within than the outside of the pump-barrel, so that an annular space is left all round between the solid piston or plug and the inside of the cylinder, into which space the pump-barrel can enter, and will fill it very nearly. The annular space is then filled with mercury. This compound piece, consisting of the hollow cylinder, with the smaller solid cylinder within it, forms the piston; and to this the power which is to work the pump is applied by means of chains, which suspend it from the short arms, so that if the lever is moved, the piston will rise up and down. When the piston is applied in its place, and the inverted pump-barrel is received into the annular space between the solid and hollow cylinders, the mercury therein will make a close fitting between the solid piston and the inside of the barrel, so as to prevent any water passing between them; and the ascent and descent of the piston will produce an alternate contraction and dilatation of the internal capacity of the working barrel, in the same manner as a solid piston would do, if it was closely fitted to the inside of the barrel with leather all round.

As the water exerts a pressure on the mercury, to force it out of the annular space in which it is lodged, the depth of the annular space and length of the barrel which descends into it must be adapted to the height to which the water is intended to be elevated; so that the column of mercury which it will contain, without raising the mercury so high as to run over the edge of the external cylinder, shall always exceed one-thirteenth part of the height to which the water is to be elevated; the weight of mercury being more than thirteen times the weight of an equal quantity of water.

That there may be less mercury used, the pump-barrel should be made of plate-iron, turned on the outside, and bored within; the outer cylinder of the piston should be bored, and the inner one turned; and if the work be well performed, eight or ten pounds of mercury will be sufficient, though the bore of the barrel, or diameter of the column of water which is raised, is six inches. Less than six pounds of mercury would suffice, if there were two barrels, in order to keep a constant stream. This will very much lessen the expence of mercury, which would otherwise be an objection against this pump; and by making the inner and outer cylinder of hard wood, as box, or *lignum vite*, the expence may still be reduced. But if the engine be very large, cast-iron bored will be proper for the outer cylinder, and cast-iron turned on the outside for the inner cylinder or plug, and hammered iron bored and turned for the middle cylinder.

There is an objection, which seems at first to take off the intended advantage of this engine, *viz.* that instead of the friction of the leather of a piston, when we lift up the piston to make a stroke, the resistance necessary to make the mercury to rise on the outside of the barrel in the outer cylinder

of the piston is at least as great as the friction we avoid. Defaguliers says, that resistance is never greater than the weight of a concave cylinder of mercury, whose height is the greatest to which the mercury rises in the said outer cylinder, and the base is the area of the barrel itself. This weight in a pump of 6 inches bore is equal to $57\frac{1}{2}$ pounds, and, therefore, it would appear to be greater than the resistance arising from the friction of a piston. But if it be considered, that in the descent of the piston for sucking, the mercury shifts immediately into the inside of the barrel, rising to the same height therein, and still keeping the same base, the weight of $57\frac{1}{2}$ pounds helps to press down the piston, and facilitates the overcoming of the force of the atmosphere, or suction of the pump; consequently, the weight of the mercury being balanced is no hindrance, whether the pump works with a double or with a single barrel.

There remains only then the hindrance by loss of time, whilst the mercury changes from the outside to the inside of the barrel, at the beginning of any stroke. Defaguliers states this to be one-fifty-second part of the stroke, and that he found the best pumps then in use generally lost near one-fifth of the water that they ought to have given, according to their number of strokes.

Notwithstanding the high terms in which this author and others have spoken of the mercurial pump, it can only be considered as an ingenious suggestion, for the expence of mercury would be too great for the actual application of any such machine in practice; and in respect to friction, it would have a considerable share of resistance in plunging the piston into the mercury, although there would be no actual rubbing of hard substances together. This resistance would arise in the rapid running of the mercury from the inside of the barrel to the outside, and back again, at the beginning of each stroke.

The machine is exceedingly ingenious and refined, and there is no doubt but that its performance will exceed that of any other pump which raises the water to the same height, because there can be no want of tightness in the piston, and friction is in a great measure avoided. But these advantages are but trifling. The expence would be enormous; for with whatever care the cylinders are made, the interval between the inner and outer cylinders must contain a very great quantity of mercury. The middle cylinder must be made of iron-plate, and without any seam, for mercury dissolves every kind of solder. For such reasons, it has never come into use. But although we have professed to describe only the machines in actual use, it would have been unpardonable to have omitted the description of an invention, which is so original and ingenious; and there are some occasions where it may be of use, such as nice experiments for illustrating the theory of hydraulics: it would be the best piston for measuring the pressures of water in pipes, being in fact the same principle as the barometer.

Sector pumps are those in which the piston is made to move upon a centre, like a door upon its hinges. The piston is inclosed within a vessel shaped like the sector of a circle, which forms the body of the pump, and which is divided by the piston into two compartments. The piston is fitted, so that it can move backwards and forwards on its centre of motion, without suffering any water to pass by it; and by this motion it will alternately enlarge or contract the capacities of the two compartments, so as to draw in water through pipes and valves properly situated, and force it out again at other pipes. These kinds of pumps are difficult to

construct, and have no advantages over the pumps with straight barrels, except for the engines for extinguishing fire. See that article for a description and figure of Mr. Rowntree's, which is one of the best of this kind.

Rotative Pumps.—As most of the first movers for hydraulic machinery act with a rotative motion, it would be very desirable to have a pump which would at once employ the rotative force to the purpose of raising water. Many schemes have been proposed, and much ingenuity displayed in these inventions; but hitherto no one has been brought to such perfection as to be equal to the pumps with straight barrels. In Ramelli's work, published in 1588, several rotative pumps are described; and Leopold has made a collection of them in his "Theatrum Machinarum Hydraulicarum," vol. i. They are all upon one common principle, viz. a hollow cylinder or drum closed on all sides; within this another smaller cylinder is inclosed, and the interior cylinder is placed out of the centre of the hollow cylinder, so that the interior cylinder touches the hollow one at one point of the circumference; but at all other points there is a considerable space between the two. The interior cylinder is provided with four or six valves or leaves, which are united to it by hinges, and, when folded close up to the cylinder, will form a smooth and circular circumference; but if the leaves are opened out, they will reach to the interior surface of the hollow cylinder. When the interior cylinder is turned round by a handle applied to the axis, the valves sweep round within the hollow cylinder, and in this motion perform the office of pistons, because they close up to the internal cylinder, in proportion as they approach towards the point where the internal cylinder touches the hollow cylinder; and the same vanes open out again, after they have passed that point. In this way the spaces between the valves form a number of cavities, which alternately expand and contract in their capacity, and in consequence they will draw up water through a pipe which is inserted into the hollow cylinder, and force it out at another pipe, so as to raise up a continual stream.

The machine is sometimes varied, by making the hollow cylinder of an elliptical form: in other cases, the valves, instead of moving upon hinges, are made to slide in straight lines from the centre of the revolving cylinder; but in either case, the action is the same. The common defect of all these rotatory pumps is, that it is very difficult to pack them so as to be tight, and they have more friction than any other kind of pump.

The *centrifugal pump*, invented by Mr. Erskine, may be called a rotative pump, but it is on a different principle from all other pumps. A perpendicular pipe has another joined to it, in form of the letter T: the lower end of this pipe being immersed in water, and the whole filled with water, it is turned round on the perpendicular stem as an axis; the water contained in the horizontal arms will, by its centrifugal force, fly out, and draw a constant stream of water up through the perpendicular pipe. See *Centrifugal Pump*.

Spiral pump, or *Zurich machine*, is a hollow drum or cylinder turning on a horizontal axis, and partly plunged in a cistern of water, like a very large grind-stone. The interior space of this cylinder or drum is formed into a spiral canal, by a plate coiled up within it, like the main-spring of a watch in its box, only that the spirals are situated at a given distance from each other, so as to form a spiral passage of uniform width. (See fig. 11. *Plate Water-Works*.) This spiral partition is well joined to the two circular ends of the cylinder, and no water can escape between them. The inner

inner end or central part of the spiral passage communicates with the axis, which is hollow at one end, and communicates with the vertical pipe which is to convey the water to the elevated reservoir. The outermost turn of the spiral passage begins to widen at about three-fourths of a circumference from the open end, and this gradual enlargement continues for nearly a semicircle; this part being called the horn. The passage then widens suddenly in form of a scoop or shovel. The cylinder is so supported, that this scoop may, in the course of a rotation, dip several inches into the water, and take up a certain quantity of water before it emerges again. This quantity is sufficient to fill the enlarged part called the horn, and is also nearly equal in capacity to one turn of the outermost uniform spiral. The vertical pipe is connected with the axis by a turning joint, so as to admit of the rotation of the axis, at the same time that it will not allow of the escape of any water.

When this cylinder is turned round by a handle applied to the extremity of the axis, a portion of water which the scoop takes up at every turn, will continually advance in the spiral, until it arrives at the centre; it will then pass through the hollow in the end of the axle, and will rise upwards in the vertical pipe; and in the intervals between the periods when the scoop dips into the water, the horn will become filled with air, and the succeeding portion of water which is taken in will carry the air before it, so that the water rises in the vertical pipe mixed with air. See SCREW.

Dr. Robinson, in his account of this machine, recommends the rising pipe to be of small bore; for if the pipe is so large as to allow the air to escape freely upwards through the water, the machine will raise the water to a certain height, proportioned to the number of turns of the spiral, and to their diameter; but if the pipe be narrow, so that the air cannot rise freely, it will rise in the pipe almost as slowly as the water. By this circumstance, the water mixed with the air becomes of a less specific gravity, as it were, and can be raised to a much greater height than it could be raised by the mere pressure of the columns of water and air in the different turns of the spiral. This is effected with hardly any augmentation of the power, but if the air, after being compressed, is suffered to escape, all the force exerted to compress it will be lost. The entrance into the rising pipe should be no wider than the last part of the spiral; and it would be advisable to divide it into four channels by a thin partition, and then to make the rising pipe very wide, and to put into it a number of slender rods, which would divide it into several slender channels, that would serve completely to entangle the air among the water. This procedure will greatly increase the height to which the heterogeneous column may be carried.

Another Form of the Spiral Pump.—When the main pipe is very high, the former construction will require either an enormous diameter of the drum, or many spiral turns of a very narrow pipe. In such cases, it will be much better to make the spiral in the form of a cork-screw, than of a flat form like a watch-spring; or, the pipe which forms the spiral may be wrapped round the frustum of a cone.

We regret that we have had no opportunity of making experiments upon a machine of this kind, as its principles of action, though treated of by many authors, are not described in a satisfactory manner in any works which we have read.

The *chain pump* is an effective means of raising water, and with the advantage of a continuous motion. It is generally made with a square or round barrel, placed in a perpendicular position. The chain is furnished with several pistons of the same figure as the barrel, which are fixed at small distances asunder upon the links of the chain. The ends of

the chain are united together, and it is extended between two wheels, one fixed at the upper end of the barrel, and the other at the lower end; but sometimes only the wheel at the top is used. These wheels have forks fixed on the circumference, which are so contrived as to receive one half of each of the flat pistons in the intervals between the forks, whilst the forks take hold of the links of the chain, and draw them up, when the wheel is turned round by means of a handle applied to the axis. The pistons on the chain are made accurately to fill the section of the barrel, at the lower part near the water, and also for a few feet upwards; but above this, the barrel is made larger, so that the pistons rise up free: indeed, the upper part of the barrel is only to contain the water which is brought up by the pistons, and may, therefore, be square, or of any other figure. The lower end of the barrel is immersed in water, and the chain being caused to circulate by turning the wheel, each piston, as it enters into the lower or bored part of the barrel, will bring up water before it in the barrel; which water will rise in the upper part of the barrel, till it runs over the top; and as the pistons succeed each other in a regular succession, they produce a constant stream. Chain pumps are chiefly used in ships, where they are worked by the force of men turning winches. (See PUMP.) In other situations they are moved by horses, and sometimes by the impulse of a stream of water. They are so contrived, that by the continual folding in of the pistons, when they enter into the bottom of the barrel, stones, dirt, or whatever comes in the way, may be cleared off. On this account they are often used to drain ponds and sewers, or to remove foul water, when no other pump could be employed.

The greatest disadvantage in the chain pump is the friction of the chain, and of the pistons, which is greater than in other pumps; because several pistons are moving in the barrel at the same time, and also because the pistons do not admit of the application of the cup-leathers, which we have described. The edges of the cups would fold up when they enter into the barrel, and get between the edge of the piston and the barrel. The pistons are, therefore, made with a thick piece of leather, which is placed between two round plates, which form the piston or faucer, as it is called; the leather is cut round to the size of the barrel, so that the edge of the leather may be applied to the inside of the barrel. In this way, its tightness must depend wholly upon the force with which the leather is squeezed into the barrel, and it occasions great friction to make the pistons sufficiently tight.

Another variety of the chain pump is an endless rope, with stuffed cushions fastened upon it at regular intervals. By means of two wheels or drums, the rope is made to circulate, and the cushions are drawn up in succession through the barrel, and each one carries some water before it.

The chain pump is found to raise a greater quantity of water to the same height, when the barrel is placed in an inclined position, than when vertical. M. Belidor recommends the barrel to be placed at an angle of 24 degrees with the horizon, and the distance between the pistons to be equal to their diameter. The reason of this advantage is, that an inclined pump acts with less friction, because the pistons need not be so exactly fitted, but they will, by their weight alone, apply closely to the bottom or lowest side of the inclined barrel; whereas the pistons of the vertical pump must exactly fill the barrel, or the water will leak down from one to the next in a constant stream.

Bellows-Pump.—A pair of leathern bellows may be employed as a pump, if a suction-pipe is applied to the lower valve, and another pipe to the nozzle, with a valve to

prevent the water returning into the bellows after it has been driven out by closing the bellows. This kind of pump has been frequently proposed, and the advantages of dispensing with barrels and pistons loudly insisted upon; but the resistance of the leather in folding, and the loss of water by leakage; and above all the want of durability, will always prevent the adoption of such pumps.

The Pump with a Diaphragm of Leather, which does not slide in the Barrel.—This is very nearly allied to the bellows-pump. The best form for constructing it is fully described in our article *SHIP'S Pump*, where the invention is attributed to Benjamin Martin; but we find the same thing was long before applied by Messrs. Goffet and De la Deuille, in France. (See Belidor's *Arch. Hydraulique*, vol. ii. p. 120.) This is a good pump, but is not durable, because the constant strain on the leather will cause it to crack.

Sucking-Pump, which gives out a continual Stream.—Mr. Smeaton applied the following simple and effectual expedient to make a single sucking-pump deliver the water equally in the descent of the bucket as in its ascent. The pump-rod was enlarged, by surrounding it with a cylinder of wood at the part where it rose above the surface of the water contained in the cistern at the top of the pump. This cylinder of wood was of such diameter, that its section was equal to half the area of the pump-barrel at the place where the bucket worked. When the bucket was drawn up, and raised water into the cistern at top of the pump, the wood cylinder, which was attached to the pump-rod, rose up out of the water in the cistern, and thereby made place in the cistern for one-half of the water which was brought up by the bucket, and in consequence only one-half of the water ran out at the spout of the cistern; but when the bucket moved downwards, in order to fetch another stroke, this cylinder of wood displaced from the cistern half as much water as the pump brought up in the former instance, and consequently an equal quantity of water was given out at the spout in either case.

If the pump is worked by the force of a man working a simple lever, then he will make the down-stroke of the bucket in less time than the up-stroke, and in this case the area of the cylinder should be made less than half the area of the barrel of the pump. It must be observed, that this contrivance is only a remedy for the unequal efflux of water from the sucking-pump, and that the power required to work the pump is still left unequal in the up-stroke and down-stroke, because it is only in raising up the bucket that the water is drawn from the well below; and that water which runs out at the spout when the bucket descends, is drawn from the cistern at the top of the pump, and not from the well. When the pump is worked by a man with a lever, this inequality of the resistance is advantageous, because a man can exert his force most conveniently when he depresses the end of the lever to draw up the bucket; also, in a single-acting steam-engine, the principal power is exerted to draw up the bucket.

In machines worked by wind, water, or horses, the moving force is uniform, and the resistance must, by some means, be made uniform also, or the machine will move by sudden starts. A sufficient weight may be applied to the opposite end of the lever to counterbalance one-half of the force necessary to draw up the bucket; this weight will tend to diminish the force of drawing up the bucket, and when the bucket descends, and the machine would otherwise have nothing to do, it will have to raise up the weight ready to aid it in the succeeding stroke. Or a fly-wheel may be applied: but a still better method is to employ two pumps to act alternately, by which means the resistance is continual, and the efflux of

water also. When two sucking-pumps are employed, they may be combined together, by making them both draw from a common suction-pipe, and both may be made to lift the water into the same cistern. Or two or three force-pumps may be combined together, as is described in the article *PUMP*, in order to produce a continuous stream.

Air-Vessel for equalizing the Discharge of Water from Pumps.—This is the most perfect contrivance for effecting that purpose. It is a close vessel of any figure, which will contain air, and is made to communicate with the pipe which conveys the water away from the pump. This communication must be made at the lower part of the air-vessel, so that the water will have free ingress and egress from it. The air in this vessel will be compressed into a smaller space, in proportion to the column of water which the pump has to raise; and by its elasticity endeavouring continually to regain its former space, it will act as a spring to equalize all sudden motions of the water through the pipe; for in any pump which acts by a barrel and piston, the water will be propelled by starts; and even if two or three barrels are combined together so as to produce a continual efflux of water, such efflux will not be perfectly equal during all the periods of the motion.

The evil of this may appear trifling and so it would be merely with respect to the discharge of the water; but it must be considered that the mass of water contained in a long pipe is very great, and that it requires a very considerable force to put this mass in motion with that velocity with which it must flow through the pipe. Now if the operation of a pump is by starts, the mass of water in the main-pipe will remain at rest, pressing on the valve during the time that the piston is withdrawn from the bottom of the working barrel. In this case, the force necessary to put the water in motion must be expended at every stroke, because if the column comes to rest only for an instant, it must be put in motion again before the operation can be resumed: this is a heavy additional load upon the first mover, and has another more serious evil in straining the pipe and all parts of the machinery; because the column of water in the pipe, after it stops, runs back for a small space until the valve shuts; and it makes just as great a concussion or shock when its motion is suddenly stopped by the shutting of the valve, as any other solid body would do which was of the same weight, and moved with the same velocity. In large steam-engines, the shock occasioned by the shutting of the valve is exceedingly violent, unless an air-vessel is applied. In that case, if the pump urges the water with a sudden motion, the air in the vessel will yield, and admit the water into the vessel in far less time than the whole column of water could be urged into motion; but as the air will become compressed by more force than the column of water in the pipe, the elasticity of the air will force the water from the vessel and up the pipe with a regular motion, and this will continue until the air has regained so much space that its elasticity is only just sufficient to balance the column of water in the pipe.

The air-vessel should be placed as near the pump as possible, that it may produce an equable motion of the water in the whole length of pipe. The air-vessel is of considerable advantage when a column of water of great length is to be raised by a single-acting pump. If the piston of the pump at one end of the pipe is put at once into motion, even with a moderate velocity, the strain on the pipe would be very great before the column of water could be put in motion. But the air-vessel tends to make the motion along the main-pipe less desultory, and therefore diminishes those strains which would really take place in the pipe. It acts like

like the springs of a travelling carriage, whose jolts are incomparably less than those of a cart, and by this means really enables a given force to propel a greater quantity of water in the same time.

The stream produced by the assistance of an air-vessel is almost perfectly equable, and as much water runs out during the returning of the piston as during its active stroke; but it must not be imagined that it therefore doubles the quantity of water. No more water can run out than what is sent forwards by the piston during its effective stroke. The continued stream is produced only by retaining part of this water in the air-vessel during the stroke of the piston, and by providing a propelling force to act during the piston's return; but it cannot enable the moving force of the piston to produce an increased effect: for the compression which is produced in the air-vessel, more than what is necessary for merely balancing the quiescent column of water, reacts on the piston to resist its compression just as much as the addition of a column of water would do, the height of such column being sufficient to produce the required velocity of the efflux.

Machines for working Pumps.—The best method of working pumps from a first mover which acts with a rotative motion, is by means of cranks; and if two or more pumps are to be actuated by the same machine, the cranks for them should be placed at regular intervals round the centre, so as to produce a continual action.

It has been observed, in our article *STEAM-Engine*, that the reciprocating motion obtained by a crank is very unequal, even when the rotative motion of the crank is quite uniform. This renders the motion of the piston in the barrel of the pump irregular, for at the top and bottom of the barrel the motion of the piston is very slow, but when the piston is at the middle of the barrel the piston moves quickly. This property is a great advantage in working pumps, because it puts the column of water in motion with a less sudden shock; but it has been very generally mistaken and considered as a defect, and many ingenious contrivances have been proposed, by means of racks and pinions, to give an uniform motion to the piston-rods of pumps. These have never succeeded in practice, and have always been laid aside.

The attempts of mechanicians to correct this unequal motion of the piston-rod are misplaced; for if it could be done it would greatly injure the performance of the pump. As this is a favourite speculation, and new attempts to perfect it are constantly making, we think it right to shew the reason of their failure.

Suppose the first mover to move uniformly with a rotatory motion, and that the machinery is so constructed, that the piston-rod will be moved up and down with a regular motion, or that the velocity of the piston shall be at all times the same, whether it is at the top or bottom, or in the middle of its course. In this case, at every reciprocation, the column of water in the main pipe must be suddenly urged into motion from a state of rest, and the machine could not perform one stroke, if the velocity of the first mover did not slacken a little, or if the different parts of the machine did not yield by bending or compression. These strains would be so sudden and violent, that no strength of materials could withstand the violence of the shocks at every reciprocation of the motion. This would be chiefly experienced in great works which are put in motion by a water-wheel, or some other equal power, exerted on a large mass of matter, of which the machine consists. The water-wheel, being of great weight, moves with steadiness or uniformity; and when an additional resistance is opposed to it by the beginning of a new stroke of the piston, its quantity of motion is but little affected by this addition, and it pro-

ceeds with very little loss of motion. The machine must therefore yield a little by bending and compression, or it must break to pieces, which is the common event.

A crank is free from this inconvenience, because it accelerates the piston gradually, and brings it gradually to rest, while the water-wheel moves round with almost perfect uniformity. It has been stated as an inconvenience of this slow motion of the piston at the beginning of its stroke, that the valves do not shut with rapidity, so that some water gets back through them; but this is a mistake, because the valves always fall by their own weight as soon as the water ceases to flow upwards through them. Now when the piston begins to move with its slow motion towards the end of the stroke, less water is caused to flow through the valves, and in consequence they close gradually, and will be fully shut by the time that the piston becomes motionless, and before it begins to return. This is shewn in the large machines, such as that of London-bridge, where the pumps are worked by cranks, and the valves close imperceptibly; but in a steam-engine of the same power, the shock occasioned by the shutting of the valves is exceedingly violent. In short, by a judicious application of the crank and a fly-wheel, or an air-vessel, and by employing two or three barrels to the pump, the evils of the reciprocating motion of pumps may be completely remedied, and on this account we consider, that if a rotatory pump could be brought to perfection, it would have no superiority over an accurate pump with a straight barrel.

Mr. Smeaton's proportions for a two-horse pump machine for raising water are as follow: horse-track thirty feet diameter; great cog-wheel nineteen feet diameter, with 144 cogs; this gave motion to a trundle of seventeen staves, fixed upon an horizontal axis, which carried a cast-iron fly-wheel of ten feet diameter, and the rim three inches by three inches. On the extremity of the horizontal axis was a crank of a foot and a half in length, which, by means of a connecting-rod, gave motion to one end of a working beam or lever of seventeen feet long, which was poised on a centre in the middle of its length, and at the opposite end was an arched sector for the chain, by which the pump-rod was suspended. The pump was a sucking-pump, six inches diameter in the barrel, and the length of the stroke was three feet. A weight was applied to the end of the beam over the crank, which was sufficient to balance one-half of the column of water in the pump. In this machine, when the horses walked two miles and a half *per* hour, they made two turns and one-third *per* minute. The trundle and fly-wheel made twenty turns *per* minute; the pump made the same number of effective strokes, and raised upwards of a hundred barrels ale measure *per* hour. By the counter balance and the fly-wheel, the resistance to the horses was rendered perfectly uniform.

The *Pump Machine at Blenheim*, which was erected by Mr. Aldersa for the duke of Marlborough, is thus described by Mr. Ferguson in his lectures. The water-wheel is undershot, and is turned by the fall of the water running down an inclined plane, and striking the floats of the wheel. The extremity of the pivot or gudgeon is formed into any number of cranks; for instance six, that is, three at each end of the axis, more or less, according to the force of the fall of water, and the height to which the water is intended to be raised by the engine. As the water-wheel turns round, these cranks move as many levers up and down, by the iron connecting-rods. These levers alternately raise and depress the pistons of the forcing-pumps by other iron rods, which are attached to the opposite ends of the levers, and as one is raised the opposite piston is depressed. Pipes go from all these pumps, to convey the water which they draw up (to a small height) into a close cistern or box, from which

devoted to the water-machines, that is, five on the London side, and one on the Southwark side.

Mr. Smeaton's great Engine at the fifth Arch of London Bridge.—This machine is represented in perspective, in Plate II. WATER-WORKS, *Machines for raising Water.* The view being taken from beneath the arch of the bridge, BB represents the starling of the fourth pier of the bridge, composed of a vast body of piles driven into the bed of the river, and the interstices filled up with chalk and gravel. Upon the heads of these piles, a set of horizontal beams are laid in the manner of joists, and all is made level by chalk and gravel.

The fifth pier CC is made in the same manner. The water-wheel FFGG is made of such a breadth as to fill the space between the two starlings as exactly as possible, without touching; and the bearings for the gudgeons of its axis are supported upon head-stocks EE, which rest upon the starlings. The water-wheel has four circular rings FFFF, each sustained by six arms mortised into the axis; each ring has twenty-four stars mortised into it, and to these are nailed the float-boards ff, upon which the water acts to turn the wheel round.

Upon each end of the main axis is fixed a large wooden wheel HH, round which cast-iron rings of cogs are fixed in segments. These cog-wheels turn two trundles, which give motion to the forcing-pumps, which are six in number, viz. one three-barrelled pump on each side of the water-wheel; but only one of the engines or triple pumps is shewn in the figure, for as the other is exactly the same, it is sufficient to describe one. The axis on which the trundle I is fixed is of cast-iron; it is connected with a triple crank, one arm of which is marked b, and two others are hidden behind the frame: ghi are strong iron rods, joined to the cranks at their lower ends, and to the ends of the great levers or regulators KLM at the upper ends.

The regulators are poised on centres in the middle of their length, and have arches klm at the other ends, which are struck from the centres of motion, upon which arches the chains are laid, to give motion to the piston-rods of the pumps N.

By the motion of the water striking the float-boards, the water-wheel is made to revolve on its axis, and the large cog-wheel H with it. This turns the trundle I and the triple cranks bc, which, being arranged round the axis at equal intervals, elevate and depress the crank-rods ghi and regulators KLM successively, and give to the pump-rods and pistons a vertical motion.

The joints of the crank-rods ghi are made to screw together round the crank-neck with brasses between; by this means they work very pleasantly, and when worn can be screwed up tight again that they may have no shake. The crank-rods are each made in two lengths, each of which has a flanch at the end, and they join at n in the middle of the rod: the flanches are held together by three screws, so as they may be taken apart occasionally without difficulty, when the pump-forcers are to be drawn out of the barrels to new leather them.

The joints at the end of the beam or levers are made with brasses, and screws to adjust them; and so are the centres or fulcrums of the levers.

The levers or regulators are admirably well designed to be strong, with but little timber; they are formed of two pieces of timber, between which the cast-iron axis on which they turn are placed; and then the ends of these pieces are bent to touch, and are kept together by hoops and screw-bolts, so as to make close joints. At the ends, several small square pieces of wood are interposed cross ways in these

joints at the ends of the lever, being let into both timbers; by these, when they are firmly bound together, the two pieces of timber are prevented from sliding end ways upon each other, so as they form an excellent truss-beam, for it cannot bend or yield without stretching one timber and compressing the other.

The pump-rods are attached to the arches at the ends of the beams by four iron chains each, as is shewn in fig. 2. The rod has a cross-piece p fixed on the top of it, to which the two outside chains are attached, and the lower ends of the same chains are fastened at the lower end of the arch.

These chains act to pull down the piston-rods; the other two chains which return or raise the rods are fastened to the top of the arch, and to the rods at the lower ends, as shewn in the figure.

The pumps are forcing-pumps, and raise the water when the pistons are depressed: the lower piece of the triple pump is a square iron-pipe or trunk, screwed fast down upon the groundfells of the engine-frame; this is called the suction-piece: it has a flanch at each end, to one of which a lid is screwed, and the other joins it to the suction-pipe R, which brings up the water from the river. On the top of the trunk, the three barrels N are screwed, each having a valve in the joint, which allows water to enter into the barrel, but prevents its return. From the bottom part of each barrel proceeds a crooked pipe q, which communicates with another square trunk S, called the forcing-piece, having valves at the joint, to prevent any water from getting back into the barrels. On the top of the trunk over each valve is a round hole, over which a lid is screwed, but can be removed to clean or repair the valves when necessary. Similar lids are screwed on over openings into the suction-trunk, at the back towards the cranks. At the ends of the forcing-trunk S are flanches, one of which receives a lid like the lower trunk, and the other flanch joins to the pipe s, which conveys the water away from the pumps.

The pistons or buckets of the pumps are solid, that is, without valves in them; and their action is as follows:

When the piston of any of the barrels is drawn up, it makes a vacuum in that barrel; and the pressure of the atmosphere on the surface of the water from which the suction-pipe R draws, raises the valve at the bottom of that barrel, and fills it with water. At the descent of the piston, the lower valve shuts, and the water contained in the barrel can find no passage but through the valve in the forcing-trunk S; and when the piston is drawn up again this valve closes, and the lower one opens to give a fresh supply of water to the barrel. By the position of the triple cranks, it always happens that one or other of the barrels is forcing the water into the force-pipes; and as the strokes of the other set of pumps at the other end of the water-wheel are contrived to be intermediate or alternating to these, a constant succession is kept up.

The main-pipe s is continued to the shore, to convey the water into the streets. A wooden cistern T is placed over the pumps to hold water, and keep a constant supply of it above the pistons to prevent leakage. The whole engine is surrounded by a strong timber fence, which guards it from the injuries it might receive from vessels or floating ice, striking it at high water, when the water rises above the level of the starlings nearly to the axis of the water-wheel. On the tops of these piles, a large stage is built, to serve as a road from the shore to the engine, and the under-side of it supports the main-pipes, which convey the water ashore. There are also other stages in different parts of the machine, to support workmen when repairing it; these prevent the whole engine from being seen from the bridge at one view, and for

for this reason they are omitted in the drawing, which is in some degree imaginary, as it represents the engine detached.

This machine is more simple than the preceding, as it performs more work by six pumps of ten inches bore and $4\frac{1}{2}$ feet stroke than the other by sixteen pumps of seven inches bore and $2\frac{1}{2}$ feet stroke, and therefore with much less loss of power by friction; and as the cranks only work in one direction, they work much more pleasantly than when there are pumps at both ends of each lever, because in that case the strain on the cranks, connecting-rods, and the fulcrums of the levers, in fact on all the joints, is alternately in different directions, and if there is any shake or looseness in the joints, it produces jerks and irregularities. By using three barrels and triple cranks, the supply of water, forced into the main-pipe, is more equable than when four are used, though not perfectly so. The perpendicular motion produced by the arches and chains, is a great advantage in making the barrels wear equally.

In order to enable this engine to work as long as possible in each tide, and after the velocity of the motive water is abated, it is contrived to adjust the resistance to the diminished power. This is done in the most simple manner by a small cock and pipe in the chamber of each pump-barrel; just above the suction-valve from this cock, a rod of communication rises up to the stage to turn it by, and this cock being opened will admit air into the barrel when the piston is drawn up, so that the water of the river will not be drawn up into that barrel; and in consequence, it will become inactive, and the wheel will be relieved from the load of working it. In this way, the load of the engine is adapted to the power of the tide at its different periods; but when all the three barrels are thus relieved by opening the air-cocks, the motion of that engine becomes a useless loud friction of the pistons and movements; and to relieve this, the shaft or axis of connection between the axis of the trundle and the triple crank, is provided with the means of disuniting or uniting them whilst in motion, so that one engine will stand still whilst the other is at work.

The principal dimensions of this machine are as follow:—The water-wheel is thirty-two feet diameter, measuring to the outside of the float-boards; the length of the float-boards fifteen feet and a half, and their breadth four feet and a half; the number of float-boards twenty-four. At each end of the axis is fixed a cog-wheel, fourteen feet diameter, with eighty cogs: each of these turns a trundle of twenty-three staves, fixed on the axis of the cranks, which are triple; that is, three cranks are formed side by side on the same axis, and bent in different directions, so as to produce a continual action. Each crank actuates a lever or working beam eighteen feet long, which is poised on a fulcrum in the middle, and gives motion to the pump-rods by an arch-head and iron chains. The pump-barrels are ten inches diameter, and the pistons make strokes of four feet and a half long; they are forcing-pumps, and three barrels are combined together, to throw the water into one main pipe, which conveys the water into the town; the highest elevation to which the water is ever lifted is a hundred and twenty feet. The cranks, beams, and pumps, at each side of the wheel, are exactly similar, so that the wheel actuates six pumps.

This machine was erected, under Mr. Smeaton's directions, in 1767, and worked constantly for fifty years, when the timber-work becoming decayed, it was rebuilt in 1817, with cast-iron instead of wood, and has been lately set to work. The principal proportions of Mr. Smeaton's design have been preserved, but the great levers have been suppressed, and the cranks are placed over the same pumps as the former.

Mr. Smeaton's Pump Machine at Stratford Water-works.—This is so like the last, that we shall only give the principal dimensions, as an example of the best proportions for a machine with a breast-wheel, the last being undershot. The water-wheel was sixteen feet diameter and eight feet wide; upon its axis was a cog-wheel of eleven feet and a half diameter, with seventy-eight cogs, which turned a cog-wheel of five feet one inch diameter, with thirty-five cogs. This was fixed upon the axis of the cranks, which were three in number, and by means of three beams gave motion to three forcing-pumps nine inches diameter and two feet and a half length of stroke, lift of the water 84 feet. In addition to the pair of cog-wheels just mentioned, there was another pair, of different proportions, fixed close to the sides of the others, and by a simple contrivance either pair could be brought into action, and the other pair would then be disengaged. The second wheel, which was fixed in the axis of the water-wheel, was nine feet eight inches diameter, with sixty-six cogs, and the wheel on the axis of the cranks which belonged to it had forty-seven cogs. The intention of these two sets of wheels was to adapt the water-wheel to work equally well when it was flooded and impeded in its motion, as when the water was low; for when the quick motion was in use, the cranks made 15.6 revolutions *per* minute, whilst the water-wheel made seven revolutions. But when the slow motion was in use, the cranks would make $15\frac{1}{2}$ revolution *per* minute, whilst the water-wheel made eleven. This machine is seven horses' power.

The *Pump Machine at Marly*, near Paris, being so much celebrated on account of its magnitude and the multiplicity of its parts, we shall be expected here to give some account of it, which we have taken from Belidor, and we shall subjoin a few remarks upon its construction, from which it will appear we do not recommend it as a model.

This machine is situated between Marly and the village La Chauffée. In that place the river Seine is penned up partly by the machine and partly by a dam, which keeps up the water; but in order that the navigation may not be interrupted, a canal has been cut, two leagues above Marly, for the passage of boats and barges. There has been erected, about thirty-five fathoms from the machine, a contrivance, called an *ice-breaker*, to prevent floating pieces of ice or timber, which come down the stream, from damaging the machine, and the better to secure the pen-flocks, and the channels in which the water-wheels move. There is a grate of timber to stop whatever may come through the ice-breaker.

The water is raised to its destined height by the force of fourteen undershot water-wheels, which work the pumps at three different stages: first, one set of pumps to lift the water from the river, to a reservoir placed up the hill two hundred and thirteen yards from the river, and at the elevation of a hundred and sixty English feet above the level of the Seine. The power of the wheels is conveyed also to this place by chains, in order to work a second set of pumps, which force the water to the second reservoir, a hundred and eighty-six feet higher, and therefore three hundred and forty-six feet above the river, and six hundred and ninety yards distant. At this spot is a third set of pumps, to throw up the water from the latter to the summit of a tower a hundred and eighty-nine feet higher, and at a distance of one thousand three hundred and thirty yards from the river up the mountain. The whole elevation is rather more than five hundred and thirty-five feet above the river. From the cistern in the tower the water is conveyed, by an immense aqueduct, to the gardens of Marly.

The breadth of the machine comprehends fourteen water-courses,

courses, each shut by a sluice or pen-stock, which can be raised and depressed by racks, and in each of these courses an undershot wheel is placed. The fourteen wheels are disposed in three lines across the river. In the first line, which is up the stream, there are seven wheels, in the second line six, and only one in the third.

The wheels are thirty feet diameter, and five feet wide, and they are all nearly the same as follow: the ends of the axle of each wheel go beyond their bearing pieces, and are bent into cranks, which make levers of two feet; the crank which is towards the mountain gives motion to a beam or lever, which carries four pistons or forcers at each end, to work in the barrels of as many forcing-pumps, which as the wheel works alternately suck up the water of the river, and drive it up into the first cistern. The other crank at the opposite end of the axle gives motion to the chains, which go up the hill, to work the pumps in the two elevated cisterns.

Each of the six wheels on the first line is constructed in this manner, to give motion by one of its cranks to an engine, consisting of eight forcing-pumps combined together. The engine is actuated by a lever or beam, from each end of which a square piece of wood is suspended, that carries and directs four pistons of forcing-pumps; the beam of the engine is put in motion from the crank of the wheel by a beam or leader, which is connected with the crank of the wheel at one end, and with one arm of a regulator or bent lever, whilst the other arm of this regulator is united by another leader to the extremity of the beam of the engine, which beam is thus made to vibrate up and down and work the pumps.

Of the six wheels we have just mentioned, there are five which, by their opposite cranks, give motion to the pumps in the elevated cistern of the first lift. This is effected by means of one vertical beam or lever, and two horizontal levers, which are bent, and actuate the chains that communicate the motion; the three levers are only to change the direction of the motion of the crank into a proper direction to go up the hill. The sixth wheel, which is the first towards the dam, gives motion to a long chain that goes up the hill to work the pumps of the upper cistern. The seventh wheel of the first line is exclusively applied to move a chain, which goes to the first cistern, by both its cranks.

The six wheels of the second line are like the five wheels in the first row, *i. e.* one of the cranks of each works an engine of eight pumps, and the other a chain that goes to the upper cistern.

Lastly, the single water-wheel, which is on the third line by each of its cranks, works an engine of eight forcing-pumps fixed in the river, and of itself supplies one conduit-pipe of eight inches and a half bore.

There are then eight engines in the river, and reckoning all the chains which go up the hill, they are thirteen in number, including the chains that come from the sixth and seventh wheels of the first line: these thirteen chains ascend the hill all together, and are suspended at regular intervals of twenty feet by levers, to bear them up from touching the ground, which by moving on their centre admit of the working of the chains. Each chain is double, that is, there is a second chain, which is connected to the opposite ends of the suspending levers, and each chain serves to draw the other chain back again after it has made its stroke. Five of these double chains are employed to actuate levers, which work thirty inverted lift-pumps situated in a cistern at the first lift, and which drive the water through two pipes of eight and a half inches bore up to the upper lift. The

other eight double chains go straight on to the upper cistern.

The seven chains of the wheels of the first line, in going along, work also eight sucking-pumps, placed a little below the cistern of the first lift, because in that place the water of a considerable spring is brought by an aqueduct, and these same chains take up that water a second time by forty-nine pumps, which are situated in a separate cistern, at the first lift, on a level with the first cistern, and force it into the upper reservoir, through two conduit-pipes of eight and a half inches diameter, and three others of six and a half inches diameter.

The water raised by the seventy-nine pumps in these two cisterns at the first lift, discharges itself into a great reservoir at the second lift, and thence by two conduit-pipes of a foot diameter each, it runs into reservoirs of communication, and is distributed into the several wells or little pump-cisterns of the upper cistern, which all together contain eighty-two inverted lift-pumps; these force the water through six conduit-pipes of eight inches and a half diameter up into the cistern, in the tower which answers to the aqueduct. These eighty-two lift-pumps are worked by the eight great chains before mentioned, that go straight to the upper cistern, without moving any pumps by the way; and the same chains work sixteen sucking-pumps behind the upper cistern, to bring back into the reservoir of the same cistern the water which leaks out of the six iron pipes that go to the tower.

To sum up all the pumps of this intricate machine:

1. The eight engines in the river contain sixty-four pumps, which suck and force the water 160 feet up five iron pipes of eight and a half inches bore, and 213 yards long, up to the first lift.

2. The two cisterns at the first lift contain seventy-nine lifting-pumps, which raise the water 186 feet, through four pipes of eight and a half inches bore, and three pipes of six and a half bore, and 477 yards up to the second lift.

3. The cisterns at the second lift contain eighty-two lifting-pumps, which raise the water 189 feet through six pipes of eight and a half inches bore, distance 640 yards: In all 225 forcing-pumps, which lift 535 feet and 1330 yards distance. To this must be added eight sucking-pumps in the river called feeders, which raise water into the cisterns at the top of the forcing-pumps, to keep water in the pumps, and prevent leakage; also the eight others which are below the midway cistern; and lastly, the sixteen sucking-pumps, which we mentioned as placed behind the upper cistern, so that the machine has in all 257 pumps.

The basin of the tower, which receives the water raised from the river, and supplies the aqueduct, is 1330 yards distant from the river, and 535 feet above the level: the water having run along a stone aqueduct, which is raised upon thirty-six arches, is separated into different conduits, which lead it to immense reservoirs at Marly, and formerly conveyed it also to Versailles and Trianon.

Such is the mechanism of the machine of Marly. Its mean produce in Belidor's time was from 3000 to 4000 English cubic feet of water *per* hour: he says mean produce, because under certain favourable circumstances it has formerly raised more than 8484 cubic feet *per* hour. But during inundations, or when the Seine is frozen, when the water is very low, or when any repairs are making, the machine stops in a great measure, if not entirely.

The annual expences of the machine have been stated formerly at 3300*l.* sterling, or 9*l.* *per* day, including the salaries of those who superintend it, and the wages of the workmen employed, together with repairs, necessary articles, &c. This makes about one farthing for every eleven cubic

cubic feet. Or, taking into the account the interest of 333,000*l.*, the original expenſe of erection, which is five times as great as the annual expenſe, 11 cubic feet, which is 67 gallons, will coſt three half-pence, or at the rate of a farthing for 11 gallons.

This is the account of it given by Belidor in his ſecond volume.

Rannequin, the inventor, was an ingenious practical mechanic, but no mathematician or philoſopher. In ſeveral poſitions, the moving forces act unneceſſarily obliquely, which occaſions a great loſs of power, and renders the machine leſs effectual. A great proportion of the whole moving power of ſome of the water-wheels is employed in giving a reciprocating motion to the ſets of rods and chains, which extend from the wheels to the ciſtern, nearly two-fifths of a mile diſtant, where they work a ſet of pumps.

As this machine is continually quoted as the moſt powerful of all machines, we will compare its power with ſome of the large ſteam-engines in England. The quantity of water is $(8484 \div 60 =)$ 141 cubic feet *per minute* \times by 535 feet, the height to which it is raiſed, = 75649 cubic feet *per minute* liſted one foot high. Divide this by 528 cubic feet, which is the quantity that can be liſted one foot *per minute*, by what is called a horſe-power in ſteam-engines = 143 horſe-power; but as the machine acts by 14 water-wheels, each one will be ſcarcely $10\frac{1}{2}$ horſe-power. The horſe-power is one-third greater than the average of horſes, and we therefore eſtimate that 215 horſes working together, would do as much work as this machine ever did, or 15 horſes to each wheel; but as the horſes could only work eight hours *per day*, three ſets muſt be kept to continue conſtantly.

M. Montgolfier informs us that the ſupply of water to the wheels is 138000 cubic feet *per minute*, and the fall is $4\frac{1}{2}$ feet; this gives a power $8\frac{3}{4}$ times as great as the effect produced. Montgolfier found $22\frac{1}{2}$ times when he tried it.

The whole work is now in a very ruinous ſtate, and many projects have been formed for a reſtoration of the machine on better principles.

It is probable Rannequin thought his moving force would not be ſufficient to raiſe the water to the height of 535 feet at once; and this is agreeable to the practice of more modern engineers.

If the machinery was conſtructed in caſt iron, in the ſame manner as ſteam-engines are now made, the force of one crank would be more than ſufficient to raiſe a cylinder of water of that altitude, and above eight inches in diameter, without any complication; but the pipes would require very great ſtrength. This is proved by a machine that has been lately erected at Marly, in place of one of the old water-wheels.

Even according to the original conſtruction, the water might be raiſed in one jet to the ſecond reſervoir. This appears from two experiments, one made in 1738, and the other in 1775. In the firſt, M. Camus endeavoured to make the water riſe in one jet to the tower; his attempt was not attended with ſucceſs, but he made the water riſe to the foot of the tower, which is conſiderably higher than the ſecond reſervoir. During this experiment the machine was ſo much ſtrained, that it was found neceſſary to ſecure ſome parts of it with chains.

The object of the ſecond trial, made in 1775, was to raiſe the water at once to the ſecond liſt, 346 feet. It did aſcend thither at different times, and in great plenty, but the pipes were exceedingly ſtrained at the bottom, ſo that ſeveral of them burſt, and it was neceſſary to ſuſpend

and recommence the experiment ſeveral times. This aroſe from a fault which might eaſily have been remedied; *viz.* from the age of the tubes and their want of ſtrength; therefore it reſults from this trial, that the chains which proceed from the river to the firſt liſt might be ſuppreſſed, together with the firſt well itſelf: and this perhaps is all that is to be expected without a complete change in the machinery.

Rules for calculating the Dimenſions of Pumps.—The quantity of water delivered by any pump will be in the joint proportion of the ſurface or baſe of the piſton and its velocity; for this meaſures the capacity of that part of the working barrel which the piſton paſſes through; and the ſame is true of ſector pumps, or rotative pumps: but as pumps with ſtraight cylindrical barrels are the only kind in general uſe, it will be ſufficient to give the rule for calculating the content of a cylinder, which is ſimply to multiply the area of the baſe by the length; thus, take the diameter of the barrel in inches, and the length of the ſtroke in feet.

Square the diameter in inches, and divide by 183.3: multiply this by the length of the ſtroke in feet, and it gives the content of the cylinder in cubic feet.

Example.—How many cubic feet of water will be raiſed in an hour by a pump $8\frac{1}{2}$ inches diameter, and $3\frac{1}{2}$ feet ſtroke, which makes 18 ſtrokes *per minute*?

Diameter 8.5 inches \times 8.5 = 72.25 circular inches: divide it by 183.3, which is the number of circular inches in a ſquare foot, and it gives .394 ſquare feet for the area of the barrel \times 3.5 feet in length = 1.379 cubic feet; the content of the barrel \times 18 ſtrokes *per minute* = 24.822 cubic feet of water raiſed *per minute* \times 60 minutes = 1489 cubic feet *per hour*.

If it is required to know the quantity which a pump will raiſe in ale gallons, it is obtained by the following rule: take the diameter of the barrel in inches, and the length of the ſtroke in feet.

Square the diameter in inches; multiply by the length in feet, and divide by 30.

This ſhould give the content of the barrel in ale gallons of 282 cubic inches each; but the rule is not perfectly correct, for it aſſumes the gallon to be $282\frac{3}{4}$.

Example of the ſame Pump as above.—The ſquare of the diameter is 72.25×3.5 feet in length = 252.875 \div 30 = 8.429 ale gallons for the content of the barrel. The true meaſure in this caſe is 8.45 gallons, which is very near.

To find the force requiſite to work any pump, take the diameter of the barrel in inches, and the perpendicular height of the column of water in feet.

Square the diameter in inches; multiply by .34 decimal, and multiply by the height of the column in feet.

This gives the force in pounds avoirdupois. It is uſual to add one-fifth to this weight, on account of friction and reſiſtance.

Example.—Suppoſe the above pump liſts the water 64 feet in the whole, what force will it take to draw up the piſton?

The ſquare of the diameter is $72.25 \times .34$ lbs. = 24.565 lbs., which is the weight of one foot high of the column \times 64 feet = 1572 lbs., the weight of the whole column. Add $\frac{1}{5}$ th of this, *viz.* 314 lbs. = 1886 lbs. the weight required to draw up the piſton and give it a proper velocity.

In conſtructing pumps, care muſt be taken to avoid all unneceſſary contractions in the valves or pipes which convey the water. If the water-way is too ſmall, the water will

WATER.

be greatly resisted in its passage through such contractions; and this is called by the workmen wire-drawing the water.

The velocity of the water in the conduit-pipe, and in its passage through every valve, will be greater or less than the velocity of the piston, in the same proportion that the area of the piston or working barrel is greater or less than the area of the passage of the valve. For whatever quantity of water passes through any section of the working barrel in a second, the same quantity must go through any one of the passages: this enables us to modify the velocity of the water as we please, and we can increase it to any degree at the place of delivery, by diminishing the aperture through which it passes, provided we apply sufficient force to the piston. This is the case in the engine for extinguishing fires; but no such increase of velocity must be suffered in pumps which are required to raise the greatest quantity of water with a given power; because the power required to force the water with a great velocity is very considerable, and the velocity so obtained adds nothing to the mechanical effect which is produced. The resistance arises from a two-fold cause; *viz.* the friction of the water against the sides of the passage, and still more from the resistance which water opposes to any sudden change of figure; for though water is a perfect fluid, and will readily accommodate itself to any change of figure by its own gravity, yet, it requires some time to make such change; and if we force it to change its figure in less time than it naturally would, it requires mechanical power to do so, just the same as to

compress a mass of clay, or other soft and non-elastic body.

In practice, the velocity with which the piston of the pump moves, determines the size of the smallest passage through which the water can pass without unnecessary resistance. Few pumps move with a greater velocity than 80 or 100 feet *per* minute; and we think the area of the narrowest passages and pipes should bear such a proportion to the area of the barrel, that the water will never be urged with a greater velocity than three feet *per* second, or 180 feet *per* minute, if the power required to move the pump is an object. In general, this will be accomplished by making the area of the smallest opening equal to half the area of the barrel; or if the diameter of the barrel is divided into 10 parts, the diameter of the least opening should be 7 of those parts. If the pump moves slower, then the passages may bear a smaller proportion. The pumps which have solid pistons are preferable, because the valves can be made of any size which is desired; but when a valve is made in the piston, its size is necessarily limited to less than we have recommended.

Estimate of the Strength of Men to raise Water.—Various authors have stated the mean force of a man so widely different, that the student is perplexed which to choose. The following table contains several of these statements, which we have reduced to one common denomination; *viz.* the number of pounds avoirdupois, or the number of cubic feet of water which a man can raise up in one minute to the height of one foot.

Authors.	Pounds Avoirdupois raised one Foot <i>per</i> Minute.	Cubic Feet of Water raised one Foot <i>per</i> Minute.	Duration of the Work.
Hachette - - - -	1343	21.5	Working 10 hours <i>per</i> day.
Amontons - - - -	1530	24.48	
Euler - - - -	3000	48.	
Smeaton - - - -	{ 3668 3750 3859	{ 58.7 60. 61.7	Working during 8 hours in 24.
Bernouilli - - - -	4144	66.3	
Schulze - - - -	4410	70.5	For 8 hours.
Defaguliers - - - -	5500	89.6	For 10 hours.
Emerfon - - - -	6300	100.8	
Dr. Robinfon - - - -	{ 5031 6648	{ 80.5 106.4	{ A feeble old man, working 8 or 10 hours <i>per</i> day, a pump without friction. { A young man weighing 135 lbs.: 10 hours <i>per</i> day.
Average of all these - - - -	4098	65.5	
True standard - - - -	3750	60.	Working 10 hours <i>per</i> day.

It is not difficult to account for these great differences, when we consider how the muscular force varies in different individuals, and also the power of enduring fatigue. The only means of ascertaining the mean force of a man is to take the sum total of the work executed by a number of men acting for a great length of time. This was repeatedly done by Mr. Smeaton, on a very large scale, and with so very little variation, that we can very confidently recommend engineers to calculate a man's force at 60 cubic feet, or 3750 lbs., raised one foot *per* minute: as this is just one cubic foot *per* second, it will easily be fixed in the memory. Defaguliers' estimate of one hoghead raised ten feet high *per*

minute, is very frequently used, and is 5500 lbs. raised one foot *per* minute, but it is too great for a man; and Defaguliers himself called it the maximum, which no machine can exceed.

When a machine is to be turned by the force of a man turning a winch or handle, the handle ought not to be longer than from 12 to 16 inches; nor should it be calculated to make more than 30 turns *per* minute; and when moving with this velocity, it should not require a greater force than $16\frac{2}{3}$ lbs. pressure upon the handle; or a man will not be able to move it without greater fatigue than he can endure for a day's work. If the handle is required to move slower,

WATER.

slower, for instance 20 turns *per* minute, then the load may be increased in proportion; *viz.* to 25½ lbs., and this will be less fatiguing.

The Force of Horses to raise Water.—This we find as variously stated by different authors as the force of men.

Authors.	Pounds Avoirdupois raised one Foot <i>per</i> Minute.	Cubic Feet of Water raised one Foot <i>per</i> Minute.	Duration of the Work.
Hachette's estimate that a horse is equal to 7 men - - - - - }	9406	150.5	Working 9 hours <i>per</i> day.
Fenwick - - - - - }	13200	211.2	
Gregory - - - - - }	18480	295.6	
More - - - - - }	21120	337.9	
Watt - - - - - }	20000	320.0	
Smeaton's 2 horse machine, with an Archimedes' screw - - - - - }	20104	321.6	Working 9 hours <i>per</i> day, light work.
Smeaton's 4 horse machine to work a flash-wheel - - - - - }	20418	326.7	Working 8 hours <i>per</i> day.
Smeaton's standard - - - - - }	22916	366.6	
Defaguliers' estimate that a horse is equal to 5 men - - - - - }	27500	440.0	{ Working 4½ hours <i>per</i> day, 4 horses were kept in order to work for 9 hours <i>per</i> day. { The strongest horses, such as are used in London, cannot work at this rate throughout the day.
Smeaton's experiment on drawing coals with 2 horses - - - - - }	27720	443.0	
Messrs. Boulton and Watt's horse-power in steam-engines - - - - - }	32000 33000	512.0 528.0	
True standard - - - - - }	22000	352	{ Working 8 hours <i>per</i> day, nearly equal to 6 men.

In this, as in the former instance, we feel inclined to give the preference to Mr. Smeaton's estimate, both from his superior experience and accuracy, and also because by his MS. papers, we are informed of the particulars of his experiments. He found, from examining the accounts of a colliery, that each horse drew 27720 pounds one foot *per* minute; but as they could only continue to work at that rate for 4½ hours *per* day, Mr. Smeaton fixed his standard at 250 hogheads *per* hour raised ten feet, which is equal to 22,916 pounds, raised one foot high. Still we find in two of his machines, of which we have already given the particulars, the performance fell rather short; we have, therefore, chosen to recommend 352 cubic feet of water, or 22,000 pounds *per* minute raised one foot high, as a standard for a horse's force, when he works 8 hours *per* day, and moves with a velocity of 2½ miles *per* hour. This is settled by universal consent as the most proper pace for a horse to walk; and he will in that case draw just 100 pounds, which is an easy number to remember.

The estimate of Defaguliers we consider as the maximum of a horse's power; for the horse-power of Messrs. Boulton and Watt is only used as a measure of the force of their *steam-engines*. See that article.

In applying horses to work machines, the circular tract in which they walk should be as large as possible, that the horses may turn round in the circle with little inconvenience. Few cases will admit of a walk of more than 30 feet diameter; and in proportion as this is diminished, the horse loses some of his power. No horse-walk should be made of less than 20 feet diameter, if he is required to act with any considerable force. When this size cannot be obtained, we are of opinion that the horse would work to a greater advantage by walking within a large perpendicular wheel, like those wheels used for cranes.

It must be remembered, that the horse should always move with a velocity of 2½ miles *per* hour, or 220 feet *per* minute; and, therefore, the number of turns which he will make in a minute must be proportioned to the size of the track in which he works.

Diameter of the Horse's Track.	Circumference.	Number of Turns <i>per</i> Minute, when the Horse walks 2½ Miles <i>per</i> Hour.
30 feet.	94 feet.	2.34
28	88	2.5
26	81.5	2.7
24	75.2	2.9
22	69	3.17
20	62.6	3.5

The machine which is to raise the water should be so connected with the principal wheel which the horse turns, that it will move with the proper velocity, when the horse-wheel turns at the rate above specified. The velocity proper for most machines is mentioned in the description of each.

Water-Wheels applied to raise Water.—The circumference of a water-wheel will work to the greatest advantage, when it moves with a velocity of from 3 to 4 feet *per* second, or from 180 to 240 feet *per* minute. A very proper velocity for a water-wheel is to make it the same as the horses, by the above table; and we have, therefore, added the velocities for smaller diameters.

Diameter.	Circumference.	Turns per Minute.
18 feet.	56.4 feet.	3.9
16	50	4.4
14	44	5
12	37.5	5.86
10	31.4	7

Few machines, with pumps worked by a water-wheel, will raise more water to a given height in any time, than amounts to one-third the mechanical effect of the quantity of water employed to work it; that is, considering the differences of the heights to which the water is raised, and the height of the fall, and reducing them both to an equality, the quantity of water raised will never exceed half of the

quantity which falls. The other half is lost in friction and leakage, and in overcoming the *inertia* of the parts of the machine.

Pressure engines are those machines which give motion to the piston of a pump, by the force of a column of water acting in a cylinder or barrel, similar to that of the pump. (See the article *PRESSURE-Engine*.) It was omitted in that article, that M. Belidor invented a machine, which may be considered as the first which was perfect, and was indeed the model for that made by Mr. Smeaton. See *Architecture Hydraulique*, vol. ii. p. 240.

M. Baillet made observations upon several machines of this kind in the mines of Hungary, from which it appears that the mechanical effect produced, is only four-tenths of the mechanical effect of the first power.

Height of the Fall of Water to work the Machine.	Diameter of the Pistons.	Quantity of Water expended in 24 Hours.	Height to which the Water is raised.	Quantity of Water raised in 24 Hours.	Ratio of the Effect, and the Cause.
French Metres.	Metres.	Cubic Metres.	Metres.	Cubic Metres.	
85.757	0.352	1900.328	89.656	817.036	0.45
89.656	0.325	2467.965	214.39	479.879	0.46
79.910	do.	685.55	46.777	394.185	0.33
79.910	do.	582.711	28.585	589.566	0.36
89.656	do.	2467.965	66.267	1336.815	0.40
					0.4 mean.

The French metre is equal to 3.281 English feet, and the cubic metre is 35.3198 cubic feet English.

Power of the largest Steam-Engines to raise Water.—The most powerful machine in existence is the steam-engine, on Mr. Watt's principle, called Stoddart's engine, at the United Mine in Cornwall. Three other engines of equal dimensions are employed to drain the mine, but only this one is loaded so as to exert its utmost force. The steam cylinder is 63 inches diameter, and acts double; that is, it operates to raise water equally in the ascent or descent of the piston. The weight of water in the pumps is 82,000 pounds, and with this load it makes $6\frac{1}{2}$ double strokes per minute of $7\frac{3}{4}$ feet each; or, it gives to the load $100\frac{3}{4}$ feet motion per minute.

Multiply 82,000 pounds by $100\frac{3}{4}$ feet, and it gives 8,261,500 pounds per minute lifted one foot high: divide this by 33,000 pounds, which is called the horse-power, and it gives 250 $\frac{1}{2}$ horse-power for the acting force of the engine. Again, divide 8,261,500 pounds by $62\frac{1}{2}$ pounds, the weight of a cubic foot of water, and we find this engine is capable of raising 132,184 cubic feet of water per minute to a height of one foot. This is not one of the best engines with respect to fuel, and it burns $31\frac{1}{2}$ pounds of coal to raise this quantity.

The whole power employed to drain the United Mine is as follows:

	Horse-Power.
Stoddart's engine, 63 inch cylinder, double acting	250 $\frac{1}{2}$
William's engine, 65 inch cylinder, do.	200
Sim's engine, 63 inch cylinder, do.	185
Poldorey's engine, 63 inch cylinder, do.	196
Total	<u>831$\frac{1}{2}$</u>

Here we have a single machine of nearly double the power of the famous machine at Marly, which is in fact composed of fourteen machines, working in concert for a common object; and so do the four engines in the mine, which amount to $831\frac{1}{2}$ horse-power, without reckoning the engines employed to draw up the ore.

The engines at several other mines in Cornwall are of immense power. We will state two.

The mine called Wheal Alfred has four engines: a 63 inch double engine, which is lightly loaded, and only exerts 80 horse-power; a single acting engine of 66 inch, and 60 horse-power; and two others of 64 and 60 inch, equal to 51 and 54 horse-power:—in the whole, 245 horse-power to drain one mine.

The Dolcoath mine has three engines: a double engine of 63 inch cylinder, and 132 horse-power; a single engine of 63 inch, and 45 horse-power; and a smaller single engine of 20 horse-power:—in all, 197 horse-power to drain the mine.

It will be observed above, that the power of the different engines is not in proportion to the dimensions of the cylinders: this is because the pressure upon each square inch of the piston varies in different engines from 7 to 20 pounds. But custom has established, that certain sizes of cylinders will be equal to a certain number of horses' power, as is shewn by the following table.

The steam in the boiler is supposed to be kept within the limits of from 2 to 4 lbs. pressure on each square inch more than the atmosphere; and in that case the cylinders of the diameters marked in the Table will have very nearly the powers assigned to them.

WATER.

A TABLE of the Dimensions of the Cylinders of the Engines, either Double or Single, showing their different Powers, either to raise Water by Pumps, or to turn Machinery by Cranks and Fly-Wheels.

Nominal Horse-Power.		Dimensions of the Piston.			Effective Pressure or Load on the Piston.		Velocity of the Motion with which the Load is raised.			Mechanical Effect expressed by the Weight which can be raised in a Minute to a Height of one Foot.			Consumption of Coals in an Hour in Pounds Weight.		
Double Engine.	Single Engine.	Diameter in Inches.	Area in square Inches.	Number of square Inches for each Horse-Power.	Pressure on each square Inch in Pounds.	Load on the Piston in Pounds.	Length of the Stroke in Feet.	Number of Strokes per Minute.	Velocity of the Piston per Minute, in Feet.		Cubic Feet of Water.	Pounds Avoidupois.	By Each Horse-Power.	Total.	Single Engines.
1	1	6.0	28	28.0	7.0	199	1 1/2	50	166 2/3	83 1/2	528	33,000	20.7	20	10
2	1	8.3	54	27.4	7.2	392	2	42	168	84	1,056	66,000	15.6	27	13 1/2
4	2	11.6	106	26.5	7.3	777	2 1/2	34	170	85	2,112	132,000	13.8	55	27 1/2
6	3	13.9	152	25.4	7.0	1070	3	31	185	92 1/2	3,168	198,000	12.2	73	36 1/2
8	4	15.9	199	24.9	6.9	1389	3 1/2	27	190	95	4,224	264,000	10.5	84	42
10	5	17.7	245	24.5	7.0	1718	4	24	192	96	5,280	330,000	10.0	100	50
12	6	19.2	288	24.0	7.1	2062	4	24	192	96	6,336	396,000	9.8	117	58 1/2
14	7	20.6	332	23.7	7.1	2357	4 1/2	22	196	98	7,392	462,000	9.0	126	63
16	8	21.75	373	23.3	7.1	2666	4 1/2	22	198	99	8,448	528,000	8.7	140	70
18	9	23.0	412	22.9	7.2	3000	4 1/2	22	198	99	9,504	594,000	8.5	153	76 1/2
20	10	24.0	452	22.6	7.3	3300	5	20	200	100	10,560	660,000	8.3	166	83
22	11	25.1	493	22.4	7.35	3630	5	20	200	100	11,616	726,000	8.0	176	88
24	12	26.1	532	22.2	7.4	3960	5 1/2	18	200	100	12,672	792,000	7.8	187	93 1/2
26	13	26.9	569	21.9	7.5	4290	5 1/2	18	200	100	13,728	858,000	7.6	197	98 1/2
28	14	27.8	605	21.6	7.6	4620	5 1/2	18	200	100	14,784	924,000	7.4	207	103 1/2
30	15	28.7	645	21.5	7.6	4897	6	17	204	102	15,840	999,000	7.2	216	108
32	16	29.5	682	21.3	7.59	5176	6	17	204	102	16,896	1,056,000	7.1	227	113 1/2
34	17	30.3	721	21.2	7.49	5500	6	17	204	102	17,952	1,122,000	7.0	238	119
36	18	31.0	756	21.0	7.7	5823	6	17	204	102	19,008	1,188,000	6.9	249	124 1/2
38	19	31.8	794	20.9	7.6	6028	6 1/2	16	208	104	20,064	1,254,000	6.8	258	129
40	20	32.6	832	20.8	7.6	6346	6 1/2	16	208	104	21,120	1,320,000	6.7	268	134
42	21	33.3	869	20.7	7.65	6663	6 1/2	16	208	104	22,176	1,386,000	6.6	279	139 1/2
44	22	34.0	906	20.6	7.7	6980	6 1/2	16	208	104	23,232	1,452,000	6.5	286	143
46	23	34.7	943	20.5	7.7	7298	6 1/2	16	208	104	24,288	1,518,000	6.4	294	147
48	24	35.3	979	20.4	7.7	7543	7	15	210	105	25,344	1,584,000	6.3	302	151
50	25	36.0	1020	20.4	7.7	7857	7	15	210	105	26,400	1,650,000	6.2	310	155
52	26	36.6	1055	20.3	7.75	8171	7	15	210	105	27,456	1,716,000	6.1	317	158 1/2
54	27	37.3	1091	20.3	7.77	8485	7	15	210	105	28,512	1,782,000	6.1	329	164 1/2
56	28	38.0	1136	20.3	7.79	8800	7	15	210	105	29,568	1,848,000	6.0	336	168
58	29	38.8	1172	20.2	7.79	9114	7 1/2	14	210	105	30,624	1,914,000	6.0	348	174

TABLE continued.—

Nominal Horse-Power.		Dimensions of the Pitton.				Effective Pressure or Load on the Pitton.		Velocity of the Motion with which the Load is raised.			Mechanical Effect expressed by the Weight which can be raised in a Minute to a Height of one Foot.			Consumption of Coals in an Hour in Pounds Weight.	
Double Engine.	Single Engine.	Diameter in Inches.	Area in square Inches.	Number of square Inches for each Horse-Power.	Pressure on each square Inch in Pounds.	Load on the Pitton in Pounds.	Length of the Stroke in Feet.	Velocity of the Pitton per Minute, in Feet.		Cubic Feet of Water.	Pounds Avordupois.	Double Engines.		Single Engines.	
								Double Engine.	Single Engine.			By each Horse-Power.	Total.		
60	30	39.2	1206	20.1	7.8	9,428	7½	210	105	31,680	1,980,000	5.9	354	177	
62	31	39.8	1246	20.1	7.8	9,742	7½	210	105	33,736	2,046,000	5.9	366	183	
64	32	40.4	1280	20.0	7.85	10,057	7½	210	105	33,792	2,112,000	5.9	378	189	
66	33	41.	1320	20.0	7.9	10,371	7½	210	105	34,848	2,178,000	5.8	382	191	
68	34	41.6	1360	20.0	7.9	10,686	7½	210	105	35,904	2,244,000	5.8	394	197	
70	35	42.	1386	19.9	8.0	11,106	8	208	104	36,960	2,310,000	5.8	406	203	
72	36	42.7	1433	19.9	8.0	11,423	8	208	104	38,016	2,376,000	5.7	410	205	
74	37	43.3	1472	19.9	8.0	11,740	8	208	104	39,072	2,442,000	5.7	422	211	
76	38	43.7	1505	19.8	8.0	12,058	8	208	104	40,128	2,508,000	5.7	433	216½	
78	39	44.4	1544	19.8	8.0	12,375	8	208	104	41,184	2,574,000	5.6	437	218½	
80	40	45.	1590	19.8	8.0	12,692	8	208	104	42,240	2,640,000	5.6	448	224	
85	42½	46.2	1674	19.7	8.2	13,750	8½	204	102	44,880	2,805,000	5.6	476	238	
90	45	47.5	1773	19.7	8.2	14,558	8½	204	102	47,520	2,970,000	5.6	504	252	
95	47½	48.7	1862	19.6	8.2	15,367	8½	204	102	50,160	3,135,000	5.5	522	261	
100	50	50.	1963	19.6	8.2	16,176	8½	204	102	52,800	3,300,000	5.5	555	277½	
105	52½	51.	2043	19.5	8.2	16,995	9	198	99	55,440	3,365,000	5.5	577	288½	
110	55	52.2	2145	19.5	8.5	18,333	9	198	99	58,080	3,630,000	5.5	605	302½	
115	57½	53.4	2242	19.5	8.5	19,166	9	198	99	60,720	3,795,000	5.5	632	316	
120	60	54.7	2340	19.5	8.5	20,000	9	198	99	63,360	3,960,000	5.5	660	330	
126	63	56.	2463	19.5	8.5	21,000	9	198	99	66,528	4,158,000	5.5	693	346½	
132	66	57.	2552	19.4	8.5	22,000	9	198	99	69,696	4,356,000	5.5	726	363	
136	68	58.	2642	19.4	8.6	22,666	9	197	99	71,808	4,488,000	5.5	748	374	
140	70	59.	2734	19.4	8.6	23,503	9	197	99	73,920	4,620,000	5.5	770	385	
145	72½	60.	2827	19.4	8.6	24,413	9	196	98	76,560	4,785,000	5.5	797	398½	
151	75½	61.	2922	19.3	8.6	25,424	9.6	196	98	79,728	4,983,000	5.5	830	415	
156	78	62.	3019	19.3	8.7	26,265	9.6	196	98	82,368	5,148,000	5.5	858	429	
161	80½	63.	3117	19.3	8.7	27,246	9.6	195	97½	85,008	5,313,000	5.5	885	442½	
166	83	64.	3217	19.3	8.7	28,092	9.6	195	97½	87,648	5,478,000	5.5	913	456½	
172	86	65.	3318	19.2	8.8	29,258	9.6	194	97	90,816	5,676,000	5.5	946	473	
178	89	66.	3421	19.2	8.8	30,435	10	193	96½	93,984	5,874,000	5.5	979	489½	
189	94½	68.	3632	19.2	8.9	32,484	10	192	96	99,792	6,237,000	5.5	1039	519½	
200	100	70.	3848	19.2	8.9	34,555	10	191	95½	105,600	6,600,000	5.5	1100	550	
212	106	72.	4071	19.2	9.0	36,821	10	190	95	111,936	6,996,000	5.5	1166	583	

This Table is formed from observations of a great number of engines of different powers, and making the intermediate sizes to correspond to the same law of increase. Thus, a twenty-horse engine is always made with a cylinder of 24 inches diameter, which is allowing 22.6 square inches of the piston's surface for each horse-power; but larger engines have a less allowance; an eighty-horse engine has 19.8 square inches to each horse-power, and small engines have a much greater allowance; a ten-horse engine having $24\frac{1}{2}$, and a one-horse, 28 square inches. This difference is to compensate for the numerous disadvantages which always attend small machines.

The proper length of the stroke for different engines is not at all settled. Mr. Watt's first engines were made much longer than this Table, but of late years they have been made shorter, and without any adequate reason which we can perceive; for it must be an advantage to a machine to make as few reciprocations as is consistent with a practicable length of cylinder. These differences in the length of stroke do not affect the calculation of powers, because if the length of the stroke is altered, the number *per* minute is also changed, and the velocity of the piston is the same; at least it will be always nearly the same as the Table for those engines which work a crank and fly-wheel. But it must be observed that these engines move with a greater celerity than the engines for pumping water, because it is necessary to accumulate a considerable velocity in the fly-wheel, or it must be immensely heavy if the piston was to move so slowly as the pumping engine generally does.

It is usual with engine-makers to calculate the velocity of the pistons of engines at 220 feet *per* minute; but we have rarely found them to come up to this in practice, and have therefore calculated them at less. In the Table, the pressure upon each square inch of the surface of the steam-piston is in proportion to the velocities there marked; and if the velocities are found less than the Table, as is the case with engines for pumping, then the load upon each inch of the piston must be increased in proportion, or else the power of the engine will be different, although the cylinder remains the same.

For instance, the engine at the Birmingham canal, mentioned in the article *STEAM-Engine*, had a twenty-inch cylinder; and being a single engine, should, by our Table, be rather more than seven horses power. How does this agree? The weight raised *per* hour to one foot high was calculated, in the article *STEAM-Engine*, at 13,961,805 lbs.; which divided by 60 gives 232,697 lbs. *per* minute: divide this by 33,000, the horse-power, and we have a seven-horse power; so far it agrees with the Table. But the pressure on each square inch of the piston was 11.7 lbs., and the Table says the pressure should be 7.1 lbs. This difference is reconciled by the differences of the velocities; for the piston of the Birmingham engine moved $63\frac{1}{4}$ feet *per* minute, and the velocity in our Table for a single engine is 98 feet: now as 11.7 lbs. is to 7.1 lbs., so is 98 feet to $59\frac{1}{2}$ feet, instead of $63\frac{1}{4}$; the difference is very small, and may be thus accounted for. The Birmingham engine, although seven horses power, had only a twenty-inch cylinder, yet, according to our Table, it should be 20.6; its piston therefore required to move rather quicker, in order to make an equal produce. Thus, the area of a twenty-inch cylinder is 314 square inches; and of a cylinder 20.6 diameter, it is 332 square inches: now as 314 square inches is to 332 square inches, so is $59\frac{1}{2}$ feet *per* minute to 63 feet *per* minute, instead of $63\frac{1}{4}$, which the engine actually moved.

The allowance for fuel in this Table is as small as it will ever be found to be in actual practice; the consumption of

fuel is not in direct proportion to the power of the engine, because small engines lose more heat, and have more friction in proportion than large ones, and the reciprocations of the motion are more frequent. We have taken the effect of the twenty-horse engine at twenty millions of pounds of water *per* minute, raised one foot with each bushel of coals weighing 84 lbs.; this makes the consumption of such an engine very near two bushels *per* hour; an eight-horse burns one bushel. We have also taken the performance of the engine of 100 horses at 30 millions, and made all the intermediate sizes by a regular law of increase; the result agrees so well with several engines which we have observed, that we considered the Table as very correct. The quantities of coal are the smallest; scarcely any engines will do with less fuel when they are working with their full load; but many engines will require more. Engines will be constantly found which are of the dimensions marked in our Table, and are called so many horse-power, although they are working with either a greater or lesser power than the Table expresses; in such cases, allowance of fuel must be altered in proportion.

We have now gone through the description of those machines for raising water which are actuated by the mechanical force of animals, or water or steam acting externally by means of levers and other connecting mechanism; but there are some machines in which a current or a column of water is made to operate within close vessels, and raise water to a considerable height: these are the Chremnitz fountain, the sypho interruptus, and the hydraulic ram. These are most admirable machines, particularly the last, because they are so simple, and having scarcely any moving parts, are not liable to decay and injury; and they do not waste the motive power in unnecessary friction and resistance.

The original steam-engines of the marquis of Worcester and Savery, which are all of this class, are fully described under the article *STEAM-Engine*. The waste of fuel in these engines is so great, that they fall very far below other engines. We have mentioned the engine made by Mr. Kier, which by a calculation will be found to raise only $2\frac{3}{4}$ millions of pounds of water one foot high with each bushel of coals, and the power of the engine is $2\frac{3}{4}$ horses. An engine of the same kind, of five horses power, which Mr. Smeaton calculated raised $5\frac{1}{2}$ millions, and this is perhaps the utmost of this kind of engines. Another engine of $2\frac{3}{4}$ horse-power, raised $5\frac{1}{2}$ millions. The best engine on Newcomen's principle will raise 10 millions; Mr. Watt's 30 millions; and Mr. Woolf's 50 millions. From this statement, it is clear that the expence of fuel in Savery's engines is so great as to counterbalance any advantages arising from their simplicity.

The Chremnitz Machine.—In this a column of water, descending from an elevated reservoir, is made to raise up another column of water from a considerable depth, and air is introduced as the medium for communicating the pressure of the motive column to that column which is to be raised. This machine is not a new invention; its principle is fully described in the Italian book, "Le Machine," by Brancas of Rome, 1629. A machine at Chremnitz, in Hungary, is so celebrated as to have given a name to this invention from its size, and the most extraordinary formation of ice and snow by the working of it, besides that it is the only one of the kind which had been applied to large works. An account was given to the Royal Academy at Paris by their correspondent M. Jars, which is inserted in their memoirs for the year 1768; and Dr. Wolfe has also described it. The machine was executed by father Hell, a professor of astronomy at Vienna, in the year 1755; it is used to raise the water in a shaft named Amalie, in the mines at Schremnitz, or Chremnitz, in Hungary; *fig. 14. Plate Water-*

ter-works, is a sketch of this machine, in which the pipes are not drawn in the proportion of their lengths, but are contracted to the space of the design. O is a wooden trough, placed in the middle of the mountain, 143 feet above the place, K, where the water drains off; this water is conveyed from the mines above it, and the fall of the water from this reservoir works the machine. There is also another trough higher up the mountain, *viz.* 260 feet above the place of delivery K, into which rain-water is conveyed for the purpose of working the machine with 260 feet fall, when a supply can be obtained therefrom; but when this supply fails, the machine is worked by the cistern O with 143 feet fall. T is an iron-pipe descending from the reservoir, to convey the water to an air-vessel of copper, A, placed at the foot of the mountain near the place of delivery. The water from the reservoir O, or from the more elevated reservoir, flows through the descending pipe T, whenever the cock H is opened: the pipe T descends very nearly to the bottom of the vessel A A, as shewn by the dotted lines X, with the intention that the air included in the vessel shall be compressed when the water enters, and forced through the tube L M into a lower vessel, B, which is similar to A, but only of half the capacity; it is placed at the bottom of the lower mine, which is to be drained at 104 feet below the delivery K, and vessel A; this lower vessel receives the waters collected in this mine from the trough D, through the pipe Q and cock C, and by the force of the compressed air introduced into B by the pipe M from the upper vessel; the water contained in B is expelled through the pipe S, which descends to the bottom of the vessel B, and is discharged at F.

The wooden trough D is the termination of a trough or channel from another engine, which raises the water from a yet greater depth; K is a pipe with a cock for discharging the water out of the vessel A, when the operation is over, in order to fill it again with air ready to repeat it, for which purpose the small pipe I is likewise opened to admit air; the cock L transmits and discharges air from the upper vessel A into the lower vessel, through the pipe M. The little pipe E, and its turncock, must be opened to let out the air from the vessel B, and it must remain open whilst B is filling, by the water from the trough D, through the pipe C Q, and it is at the orifice of the little pipe E that snow and ice are generated. A valve is placed at the lower ends of the pipe F S, to prevent the water from escaping out of the pipe F S, after it has been raised, and whilst the vessel B is filling with fresh water.

The operation is performed thus: two men are placed at the vessels A and B to open and shut the cocks; suppose all the cocks shut, and the reservoir O, at 143 feet high, is always full; the pipe T H is also full as far as the cock H; the reservoir D is kept constantly full of water from the mine, which is to be drained by raising the water from D to F, 104 feet; for this purpose, it must first be admitted into the vessel B: the cock C is therefore opened, and the water flows into B, the air being at the same time suffered to escape from that vessel by opening the cock E. The vessel B is known to be full by the emission of water at E, at which instant both the cocks C and E are to be closed. The machine is now prepared for the operation, which is began by opening the cocks H and L; the descending water from the reservoir O enters the vessel A, and compresses the included air till its elastic force becomes equal to the pressure of the column of water D F, and then the air descends through the pipe M, and enters the lower vessel B, where it presses on the surface of the water contained in the vessel, and forces that water to ascend through S to F, which opens into the adit, through

which the water is discharged from the mine. This water being raised, the lower vessel B is become filled with condensed air in place of the water, and the upper vessel A is become filled with water in place of the air. The cocks H and L are then shut, and K and I are opened; the cock K suffers the water contained in A to flow off, and I accelerates the discharge, by admitting the external air into the vessel A; and both these cocks are closed again as soon as the evacuation of the upper vessel is completed. During this last operation another man below opens the cock E, by which the condensed air included in the vessel B issues with great force through E; he then opens C, and the water from D again fills the vessel B, as at first; this being done, he closes C and E.

The apparatus is now charged again ready for action, and by opening H and L the above operation will be repeated; *viz.* the contents of B will be forced up to F, and thus the engine may be kept continually at work as long as the two reservoirs O at the top, and D at the bottom, are kept supplied.

The dimensions of the principal parts, as given by father Hell, are as follow, in Hungarian measure:

The diameter of the upper vessel A $32\frac{1}{2}$ inches; its height 60 inches; the thickness of the copper $1\frac{1}{4}$ inches.

The iron-pipe T is 260 feet; from H, to the most elevated reservoir above O, it is $4\frac{1}{2}$ inches bore; and the thickness of the metal is $1\frac{1}{4}$ inches.

The lower reservoir O 143 feet above H.

The pipe F S, 104 feet long, $3\frac{1}{2}$ inches bore.

The air-pipe L M is formed narrower towards the bottom; at its upper end it is two inches bore, and at its lower end 1 inch; thickness of the metal $1\frac{1}{4}$ inches.

The Chremnitz foot is to the Paris foot, as 1538 to 1440; the pound, as 106 to 92. The Paris foot to the English, as 32 to 30.

A cubic foot of water of the mine weighs 72 lbs.

The upper vessel A contains $57\frac{1}{2}$ cubic feet, and the lower vessel B $27\frac{1}{2}$.

Twenty-five cubic feet are raised at every operation, and sometimes $31\frac{1}{2}$ feet, as the water descends from the upper or lower reservoirs at O, the duration of the operation being different; for when the upper cistern O is used at 260 feet of elevation, 20 or 21 draughts are made in an hour; but when the lower cistern is used at 143 feet elevation, only 17 or 18 draughts *per* hour.

Each of these vessels is cast in three pieces, which are joined by flanches and screws, with a ring of lead and another of leather placed between each to secure the joint, and prevent the transmission of any fluid. M. Jars observes that the pipes would have been better if connected by flanches, in the manner shewn by the figure; but the real practice is to drive the ends of the pipes into hollow cylinders of dry wood, bound with iron hoops; these answer tolerably well, and are of considerable durability.

The moveable plugs of the cocks, C, E, K, are screwed in their places by caps or covers fastened down with screws.

The produce of water raised by this machine is thus estimated by Dr. Wolfe:

If the vessel A were completely emptied after each operation, the expence of water, when the fall of 260 feet is used, would be 1178.25 cubic feet in an hour, descending 206 feet; and the effect, or the water raised, would be 563.75 cubic feet to a height of 104 feet; or, when the fall of 143 feet is used, the expence *per* hour would be 1006.25 cubic feet, and the effect 481.25. But as it is not necessary that the vessel A should be much more than half emptied, the expence of water will be nearly equal to, or will not much exceed the quantity raised.

It should follow, from experiments on the nature of air, that the column FD is counterpoised by the compressed air in the inverse ratio of 104 to 32: hence the volume of air contained in the vessel A and the pipe LM, equal to $58\frac{1}{2}$ cubic feet, must be reduced to 18 cubic feet, before the elasticity will be equal to the pressure of the column CF 104 feet; but by increasing the compression a little more, the water in B will be made to flow out through F.

If, at the moment the vessel A is full of water, the cock H be shut, the water will continue to flow through F, until the air occupies a space of 18 cubic feet in the vessel B, and in the pipe LM; the elasticity of the air will then be in equilibrio with the column FD, and the efflux of the water through F will cease. In this manner, not above 17 cubic feet of water are evacuated at each draught, and $10\frac{1}{2}$ cubic feet are constantly left in the vessel B.

But if the cock H is not shut the very moment that the vessel A is full, the water in A will follow the air through LM, and, before it gets to the vessel B, will raise one cubic foot more out of that vessel. After the water from A enters into the vessel B, the discharge at F will not be the water of B, but the water of A descending and ascending again by a useless circuit, until H be shut; which being done, the water will continue to flow at F, until the remainder of $10\frac{1}{2}$ cubic feet is expelled from B by the air contained in it. The moment when the water from A has descended into the lower vessel B may easily be known, by the velocity of the efflux at F becoming suddenly three times greater.

That this is actually the case is proved, because sometimes $31\frac{1}{2}$ cubic feet are discharged; which quantity exceeds the capacity of the vessel B by more than 4 cubic feet.

This inconvenience might easily have been prevented, by giving to the pipe S a diameter of 18 inches; for then there would have remained only the just space of 18 cubic feet for the compressed air.

The height of the column T to the lowest of the two reservoirs at O is 143 feet, which, taken upon the diameter of the vessel A as a base, is equal to the weight of $822\frac{1}{4}$ cubic feet, and would compress the air into a fourth; or, when the water is descending into the lower vessel B, into a seventh part of its natural space, provided it were equally resisted at F. The vessel A becomes filled at a mean in 8 seconds; and in twice that space of time, 17 cubic feet are evacuated through F.

The power of the column of 260 feet from the most elevated reservoir, acting within the vessel A, is equivalent to the weight of 1495 cubic feet of water. It can raise a greater quantity, if the vessel B be so constructed as to allow no more than a just space to the compressed air. If the vessel A were filled in 4 seconds, then 17 cubic feet of water would be discharged through F in twice that time, and the air would be reduced into an eighth, and, during the descent of the water of the vessel A into the lower vessel B, into an eleventh part of its bulk. But this makes no alteration as to the quantity of the effect; and when water ceases to flow out at F, there will always remain $10\frac{1}{2}$ cubic feet of water in the vessel B.

Two men are required to attend it, but it would be very easy to connect the levers of the cocks above and below, so as to require only one man to work the whole set; and indeed there would be little difficulty in making the machine work itself safely, without any attendant, except to set it off at first, or stop it when requisite. The machinery for this purpose has been proposed by Mr. Boswell. See Nicholson's Journal, 4to. iv. 117.

From what has been said, it is evident that this machine,

though it answers the author's intention, is so deficient as to the effect the same fall of water might produce, as to bear scarce any proportion; and there is a defect in the principle of the machine, *viz.* that the air will require a considerable share of the power to compress it, and this air must be suffered to escape, before the vessels can be refilled to repeat the action; in consequence, all the power taken to compress the air is lost, and expands itself in forcing out a strong blast of air at the discharging cock, without producing any useful effect. Notwithstanding this defect, the cheapness and ease of construction, and the little wear and tear, together with the facility with which it may be made to work and stop for very short periods of time, are powerful recommendations of this machine, in such places as afford the requisite fall of superior water, and do not require a higher single lift than 15 or 20 fathoms.

A curious phenomenon has been observed in this machine, when it is near the end of its operation, that is, when nearly the whole of the water has been raised out of the lower vessel B, and the cock E be opened to give vent to the compressed air, and before the cock L is shut, so that the air is followed up by the water, then if a hat or miner's bonnet be presented to the aperture E, the aqueous vapours dispersed through the compressed air, and perhaps also, says M. Jars, part of those of the external air are condensed in the bonnet in the form of very white and compact ice, very much resembling hail, and not easily separated from the bonnet. It soon melts, which is not to be wondered at, as the temperature of the place itself is not cold. Messrs. Du Hamel and Jars remained in Hungary from January to July 1758, and observed the same phenomenon at all seasons; but as they had no thermometer, they could not make a number of experiments, which might have been of value in the investigation of the subject.

It is observed that the air issues out with such impetuosity, that the workman could not hold the bonnet at the distance of a few inches from the aperture, as he does in this experiment, if he were not supported behind. The ice is much more compact, if the cock be only in part opened.

When the cock at which the air is discharged is opened, it rushes out with prodigious violence, and the drops of water are changed into hail or lumps of ice. It is a sight usually shewn to strangers, who are desired to hold their hats, to receive the blasts of air: the ice comes out with such violence as frequently to pierce the hat like a pistol bullet. This rapid congelation is a remarkable instance of the general fact, that air, by suddenly expanding, generates cold; its capacity for heat being increased.

The formation of the ice and snow, when the condensed air rushes out of this machine, has been explained in a different way in almost every system of philosophy. It appears to us to be a necessary consequence of the condensed air, on rushing out into the open air.

The air of the atmosphere, and the water when taken into the machine, are nearly of the same temperature; and it may be considered that each cubic foot of water and of air contains some certain quantity of heat or caloric; but they will readily impart a portion of this heat to any body containing a less degree than themselves, or they will absorb or take up heat from any body containing a greater proportion of heat than themselves, in consequence of that property of heat, by which it will distribute itself equally among all bodies which are in contact with each other. By the action of the machine, the air is compressed into one-third of the space it before occupied, and the share of heat contained in that air is likewise concentrated or thrown into a third of the space, and in consequence becomes more intense. Some part of

the heat will, therefore, be communicated to the surrounding water, until the heat distributes itself again between the water and the condensed air, so that they come to the same temperature. In this state, if the air is suffered to rush out of the vessel, it will suddenly expand and recover its former volume, and it must also recover its former share of caloric, which it can only do by abstracting heat from the surrounding air, or from any substance with which it comes in contact: hence the coldness of the blast of air. In respect to the formation of snow and ice, it must be considered that the air of damp places always contains a considerable portion of water in a state of vapour, and the air in this machine will have taken up more than the ordinary share, in consequence of being in contact with the water. When the air expands itself, the heat being suddenly abstracted from this watery vapour, it becomes fluid, and accumulates in drops like rain; which drops, by a farther abstraction of heat, become solid like snow or hail.

An instrument which is in common use to produce fire, by the sudden compression of air, shews the reverse of this action: it is a syringe fitted with a piston, which is air-tight; at the bottom of the barrel a small piece of tinder is placed. Now, if the piston is very violently and suddenly forced down to the bottom of the barrel, and the piston is then withdrawn, the tinder will be found on fire. The heat contained in the air which fills the barrel is so concentrated at the same time with the air, as to produce actual fire. If the piston is forced slowly down, the air will be condensed to an equal degree, but no fire will be produced, because the heat has time to escape through the metal of the barrel, before it arrives at any considerable degree of concentration. We consider that in all cases when air (and perhaps other elastic fluids) is compressed into a smaller space, part of the heat it before contained will be given out to the surrounding matter; or if it is suffered to expand to fill a larger space, it will absorb or take up heat from the surrounding matter.

A larger Machine at Chremnitz.—This does not differ from the original machine, so as to require a minute description; but as this machine is not employed in England, and we think it might be useful in many cases in mining districts, we shall give the proportions and calculations of a larger machine, as a model for engineers.

	Feet.
Height of the source above the place of delivery or fall of water, which is to work the machine: descending pipe 4 inches bore	136
Depth from which the water is to be raised out of the pit to the place of delivery: ascending pipe 4 inches bore	96
	Cubic Feet.
Upper vessel a copper cylinder 5 feet diameter, and 8½ feet high; metal 2 inches thick; the descending pipe goes to within 4 inches of the bottom: contents	170
The lower vessel a brass cylinder 4 feet diameter, and 6½ feet high; metal 2 inches thick; the ascending-pipe goes within 3 inches of the bottom: capacity	83
Air-pipe which communicates between the two vessels, 2 inches bore, and 96 feet in length	}

To understand the action of this machine clearly:—Suppose that the lower cylinder is charged with water, and the upper cylinder with air ready for action; when the water from the source is admitted into the upper cylinder, if no issue was given to the contained air, the water would enter into the vessel, until the air was compressed into one-fifth of

its bulk by the column of 136 feet high; for a column of 34 feet nearly balances the ordinary elasticity of the air. But when there is an issue given to the air through the air-pipe, it will drive the compressed air along this pipe, and it will expel water from the lower cylinder.

When all the air is expelled from the upper cylinder, there will be 34 cubic feet of water expelled from the lower cylinder. Now if the ascending pipe had been carried up more than 136 feet above the lower level, instead of 96 feet, then the water would have risen 136 feet high in that pipe, by the intervention of the elastic air, before it was in equilibrio with the water in the descending pipe; but no more water would have been expelled from the lower cylinder than what would fill this pipe.

But the ascending pipe being only 96 feet high, the water will be thrown out at the top of it with a considerable velocity. Were it not for the great obstructions which the water and air must meet with in their passage along the pipes, it would issue from the mouth of the ascending pipe with a velocity of more than 50 feet per second. It issues, however, much more slowly.

When the upper cylinder is become filled with water, the supply is stopped; but the lower cylinder still contains 34 cubic feet of compressed air of sufficient elasticity to balance the water in a discharging-pipe 136 feet high, whereas the ascending-pipe is only 96 feet. Therefore the water will continue to flow at the mouth of the ascending-pipe till the compressed air is so far expanded as to balance only 96 feet of water, that is, until it occupies one-fourth of its ordinary bulk, or one-fourth of the capacity of the upper cylinder, viz. 42½ cubic feet. Therefore 42½ cubic feet of water will be expelled, and then the efflux will cease, leaving the lower cylinder about one-half full of water.

When the discharging-cock of the upper vessel is opened the water issues with great violence, being pressed by the condensed air returning from the lower cylinder. It therefore issues with the sum of its own weight, and of this compression. These gradually decrease together, by the efflux of the water and the expansion of the air; and this efflux stops before all the water in the upper vessel has flowed out, because there are only 42½ feet of the lower cylinder occupied by air. This quantity of water nearly will therefore remain in the upper cylinder. The workman knows this, because the discharged water from the upper vessel is received first of all into a vessel containing three-fourths of the capacity of the upper cylinder, which serves as a measure; when this is filled, the attendant opens the cock which admits the water into the lower vessel, by a long rod which goes down the shaft: this allows the water of the mine to fill the lower cylinder, and the air returns into the upper cylinder through the air-pipe, and permits the remaining water to run out of it; and when the attendant finds no more water will come out, every thing is brought to its first condition.

The above account of the procedure in working this engine, shews that the efflux at the mouth of the ascending-pipe becomes very slow near the end. On this account, it is found convenient not to wait for the complete discharge, but to cut off the supply when about 30 cubic feet of water have been discharged, and more work is done in this way.

A gentleman of great accuracy and knowledge of these subjects, took the trouble of noticing particularly the performance of the machine. He observed that each stroke, as it may be called, took up about three minutes and one-eighth, and that 32 cubic feet of water were discharged, and 66 cubic feet were expended.

The expence therefore is 66 cubic feet of water falling

WATER.

136 feet, and the performance is 32 cubic feet raised 96 feet, and they are in the proportion of 66×136 to 32×96 , *viz.* 8976 to 3072, that is the power employed is to the effect produced, as 2.9 to 1. The quantity raised, *viz.* 32 cubic feet, divided by the time $3\frac{1}{2}$ minutes, gives very nearly 10 cubic feet *per* minute, and multiplied by the height raised 96 feet = 960 cubic feet raised 1 foot high. Divide this by 528 cubic feet, which is the horse-power, and it gives 1.8. The machine is not therefore equal in effective power to a steam-engine of two-horse power, but the power employed is just equal to five-horse power.

When we consider the great obstruction which water meets with in its passage through long pipes, we find we may gain some advantage by increasing the bore of the descending-pipe of supply. The quantity of water which descends through this is 66 cubic feet in $3\frac{1}{2}$ minutes, or very nearly 30 cubic feet *per* minute; the area of the four-inch bore is 12.5 square inches, and therefore 11.5 such areas would make a square foot. Multiply 30 cubic feet by 11.5, and we have 345 feet, which is the velocity with which the water must descend in the pipe. This is much too great, and it would be an improvement if the pipe was increased to six inches bore, and the velocity would then be only 151 feet *per* minute. The performance of the machine would then be greatly increased, we think as much as one-third; it is true that it would expend more water, but not in the same proportion; for part of the deficiency of this machine arises from the needless velocity of the water in the pipe, as well as from the violent efflux of the water by the condensed air, as we have before mentioned.

The discharging-pipe ought to be 110 feet high instead of 96, and would not give sensibly less water. It must be considered if the original expence of this simple machine would not be less than a water-mill which would raise 10 cubic feet of water, 96 feet high, in a minute; the repairs of it would be small when compared with a mill. And, lastly, let it be noticed, that such a machine can be used where no mill whatever can be put in motion.

A small stream of water, which would not move any kind of wheel, will raise one-third of its own quantity to the same height, working as fast as it is supplied.

From its simplicity, we think the HUNGARIAN Machine (which see) eminently deserves the attention of mathematicians and engineers, to bring it to its utmost perfection, and into general use. There are many situations where this kind of machine may be very useful. Thus where the tide rises 17 feet, it may be used for compressing air into seven-eighths of its bulk, and a pipe leading from a very large vessel inverted in the tide-water may be used for raising water from another vessel of one-eighth of its capacity, 15 feet high; or if this vessel has only one-tenth of the capacity of the larger one set in the tide-way, two pipes may be led from it, one into the small vessel, and the other into an equal vessel, 16 feet higher, which receives the water from the first. Thus one-sixteenth of the water may be raised 34 feet, and a smaller quantity to a still greater height, and this with a kind of power that can hardly be applied any other way.

Sipho Interruptus to raise Water by Suction.—This machine is the reverse of the Chrennitz machine in its action, for the power of a descending column of water, running out of a close vessel, causes a vacuum therein; and another column of water is sucked up into the vessel, or rather forced up by the pressure of the atmosphere to fill the vacuous space. This machine is fully described by Leopold, in his *Theatrum Machinarum Hydraulicarum*, vol. i. It is provided with apparatus to open and shut the cocks. It would be difficult to explain this machine without several figures, and we

have therefore preferred to describe a machine of the same kind invented by Mr. Goodwin; he calls it a machine that will raise a body of water to any height not exceeding the height of that column which will counterbalance the pressure of the atmosphere, (say 30 feet) and acts by the descent of part of the same body of water through a somewhat greater height, aided by the pressure of the atmosphere.

Let A, *fig. 10, Plate Water-works*, be a spherical vessel of copper or other metal, about 18 inches diameter; B, another sphere, about two feet six inches in diameter; C, a reservoir kept constantly supplied with water, part of which is to be raised up to E, by the power of another part descending to a considerable depth beneath the reservoir C. D is a glass cap, about six inches long, fixed on the top of the upper vessel A, for the purpose of seeing when the water begins to fill and has filled it; E is the upper reservoir into which the water of the reservoir C is to be elevated, and the contents of the upper vessel A is to be emptied; 1 is a pipe about half an inch in diameter, joined into the top of the lower vessel B, and rising upwards to within about an inch of the top of the glass cap D of the upper vessel; 2 is a pipe of the same diameter, and a few feet longer than 1, 1, joined to the bottom of the lower vessel B, and descending downwards in a perpendicular or inclined direction, to a rather greater distance beneath C than the upper vessel A is elevated above C; 3 is a pipe one inch and a half in diameter, joined to the bottom of the upper vessel A, and passing upwards through the bottom to within two inches of the top of the glass cap D; 4, 4, is a pipe of about half an inch diameter, joined to the top of the vessel B, it passes through the bottom of the reservoir C, and rises above the surface of the water therein; 5 is a pipe of the same diameter, fixed to the top of the vessel B, and terminating in and fixed to the bottom of the reservoir C; a is a pipe or spout of the same diameter, fixed into the bottom of the upper vessel A, to convey the water into the reservoir E; 7 is a trumpet mouth-pipe fixed to the bottom of the pipe 3, and extending downwards beneath the water to within about an inch of the bottom of the reservoir C; a, b, c, and d, are cocks fixed to the pipes. The vessels, pipes, cocks, and joints, must all be air-tight.

In order to raise water from the lower reservoir C into the upper reservoir E, all the cocks being shut proceed thus: open the cocks b and c, in order to fill the lower vessel B, and when B is filled, shut the cocks b and c, and open the cock d. The water will then begin to run from the sphere B by its gravity, and by means of its communication with the upper sphere A, through the pipe 1, will draw off the air therefrom to supply the space left in the lower vessel B, by the running out of the water the air in A is thus rarefied. The atmospheric air at the same time pressing on the water in the reservoir C, will cause it to rise through the trumpet-mouth 7 of the pipe 3, and by falling over the top of the pipe 3 at D, it will fill the upper sphere A. When A is full, which may be seen through the glass cap D, shut the cock d, and open the three cocks a, b, and c, the cock and pipe b will allow the atmospheric air to return into the vessel, and fill both with air, by which means the water contained in the vessel A will run into the elevated reservoir E, and B will be replenished for another operation. Then shut the cocks a, b, and c, and open the cock d, and it will repeat the operation of raising the water into A.

If it be required to raise any body of water from reservoir C into reservoir E, by means of the descent of a body of some other water from the vessel B, a communication must be made into B, independently of the pipe 5, and

cock *c*; viz. through a pipe-cock leading from another reservoir, as is represented by the dotted lines communicating with B near the pipe and cock 5; the action is the same as before; but the cock with the dotted lines is to be used in lieu of pipe 5, and cock *c*. By this means, if the water which is employed to work the machine is foul or tainted, it will have no communication with the water which it raises. This machine has the same defect as the Chremnitz machine; viz. that the power which is expended in rarefying the air is greater than the quantity of water raised, and the difference is lost when the cock in the lower vessel is opened, and the air rushes in.

A different Form of the Siphon Machine.—Mr. Goodwin's engine is formed upon a very elegant principle, and operates by the assistance of only a small quantity of water. It may be made in various forms, either to raise the fluid above the descending column, or from below it to a level with the bottom, and the height may be doubled or trebled by proportionally increasing the descending mass, and raising several columns of water from different elevations at the same time, by combining two or more of the simple machines together, as is shewn in *fig. 8. Plate Water-works.*

C, as in the former figure, represents the reservoir or source of water which is to work the machine; B represents the lowest of the two vessels which contain the rising and descending bodies of water; and the small square near *fig. 8.* represents the upper vessel A, *fig. 10.* These vessels are spherical in the original drawing, but to lessen the loss of space in descent, they are here made flat and cylindrical; E is the higher cistern of the original figure, into which the water is to be raised; 2, 3, and 4, are the pipes arranged in the same manner as the former machine; F, a vessel the same as A, with tubes 3 and 6: it communicates with the vessel B by a pipe, and is intended to raise water out of the cistern E into a higher and additional cistern G.

The vessels E, F, and G, form a second machine, which has the same parts and properties as the former, except that the lower vessel B is common to both, and serves as the lower vessel to exhaust and drive up the water both to A and to F; 2 is an enlarged tube like the original drawing, through which the water descends to produce the action; 5 is a hole in the top of B, instead of a tube. This hole, and the tubes 2, 4, and 6, must be provided with valves instead of cocks, which must be kept close by weights or springs, (while the water is rising) except the valve to tube 2, which must be open. The tubes 3, 3, may also have valves to support the raised columns.

Operation.—Fill the cisterns C and E with water, and let the lower cistern be constantly supplied; open the valves of the tubes 4, 5, 6, 6, and close the valve of the descending-tube 2, the vessel B then becomes filled through the hole 5. Now close the valves of the tubes 4, 5, and 6, and open the valve of the tube 2, the water will then begin to descend out of B, and will exhaust the air from A and F, just as in the first-mentioned machine; the pressure of the atmosphere on the surface of the water C, will raise one body of water out of C into A, and out of E into F; when B is nearly empty, or when A and F are full, open the tubes 4, 5, 6, 6, and close 2, then B will be filled a second time, and the vessels A and F will empty themselves into their respective cisterns E and G: thus the reciprocations continue without interruption.

Another body of water may be raised out of G into a higher cistern by additional apparatus, and by proportionally increasing the dimensions of the vessel B and the tube 2. The dotted lines represent the apparatus for raising water

below the bottom of the tube 2, to be used instead of those above the cistern C.

This arrangement of the engine is of great utility in many cases; and in situations where this machine can be erected, it may be of considerable use for raising water out of mines for draining pieces of land, or elevating the water employed in domestic purposes.

Comparison of different Pressure-Engines.—In Mr. Nicholson's Journal, 8vo. vol. i. Mr. Boswell has given a plan for constructing Mr. Goodwin's engine on a large scale, to operate without attendance of any person, to open and shut the cocks, and another method of causing the Chremnitz machine to raise water above the level of the prime reservoir; and he makes the following comparative view of the advantages of both kinds of engines and their powers.

It will be found that the powers and capabilities of these machines are nearly similar. 1st, In both the greater the height of the original fall of water from the source to the discharge, and the greater the quantity of water which it can supply in a given time, the greater quantity can be raised by either of these engines in a given time. 2dly, Both engines can be constructed so as to raise water above the original level, and from below, to the surface, or from a pit. 3dly, By a successive number of reservoirs, both engines can be brought to raise water to any height, but as they will raise a smaller quantity as the height is increased, the quantity wanted in a given time, and the expence of construction, will limit the extent of their elevation. 4thly, In both engines the distance of one reservoir from another must always be less than that of the original fall: the circumstances in which these engines differ arise from the difference in their manner of action. 5thly, The Chremnitz engine operates by causing a fall of water to compress the air, which reacting on other water, forces it to rise in a pipe to a certain height. The syphon engine acts by causing a fall of water to rarefy a certain quantity of air, in whose space the pressure of the atmosphere forces a quantity of water when permitted. 6thly, Hence in the Chremnitz engine the pressure acting from within outwards tends to burst the vessels used in the structure, and to open and extend any fissures which may chance to be in them. 7thly, In the syphon engine, the pressure acting from without inwards, closes all the parts of which it is composed more together. 8thly, The Chremnitz engine will always raise water of a height nearly equal to that of the original fall from one reservoir to another, supposing the original fall of any height whatsoever as 100 feet. The syphon engine will not raise water by one reservoir so high as thirty feet in any case whatsoever, as there cannot be a complete vacuum formed by it in the air-chamber, but only an approximation to one.

From this comparison, it will follow that wherever the original fall of water is less than thirty-two feet, the syphon engine will be much preferable to the Chremnitz, as from the seventh article of the comparison it may be made of the cheapest materials, such as strong wooden casks and wooden pipes, whereas the Chremnitz engine from the sixth article must be made of the strongest, and of course the most costly materials, as metal, and that of considerable thickness; but wherever the original fall exceeds the height of thirty feet considerably, and it is required to raise the water to nearly the same height, then the Chremnitz engine appears to be preferable, as, in all probability, the fewer number of parts which it will require in this case will more than compensate for its cost in materials.

When it is required to raise water to a height much greater than that of the original fall above the first level, or from a greater depth, either from the original fall being short, or the

the required height being great, it is better to employ an engine in which the pressure of the water is made to act by a piston in an apparatus similar to that of a steam-engine. (See our article *PRESSURE Engine*.) When neither the syphon engine nor the Chrennitz can be used without a number of reservoirs, then the piston pressure-engine ought to be preferred, but this will much depend on the number of reservoirs; for perhaps one or two in addition to the Chrennitz might cost less than boring the cylinder of the piston-engine perfect, and constructing its additional machinery. For merely raising water the powers of each are nearly equal, depending entirely on the height of the original fall of water.

It would be a great advantage of the piston-pressure engine if a fall of water could be applied to it without any waste, to work mills or machinery for any purpose; this would be of very great consequence when the fall of water is of considerable height, and the stream or supply small. We have mentioned the advantage in this engine to have its action made elastic, by the addition of an air-chamber, on the same principle as that used in engines for extinguishing conflagrations. Mr. Boswell suggests that this might be effected by making the piston hollow, and of a larger size, to contain air for this purpose, as the air's elasticity would then act both on the upper and lower pressure of the water.

Machine for raising Water by the lateral Communication, from the Motion of a Stream of Water running through a conical Tube.

—This machine operates by suction, or more properly by the pressure of the atmosphere, and is in some respects similar to the syphon machine. (See *fig. 9. Plate Water-works*.) A A represents a reservoir of water kept constantly full, at the same time that the conical spout, B, is running full under a considerable pressure; D, a spherical copper vessel, with a tube, C, joined into its bottom, and rising up within to some height above the centre of the sphere; E, another tube joined to the bottom of the sphere D, and terminating near its top; the lower part of this tube is bent, and the extremity of it is introduced into the smaller apertures of the conical tube B; F, a spout or tube to empty the vessel D, when it is filled with water which has been raised up out of the reservoir A; G, a small tube passing through the spout F, and rising to near the top of the sphere, D, for the admission of air to quicken the descent of water out of that vessel. Both these tubes are closed at their lower ends by a leather valve at the end of the lever L, which lever is fixed upon the turning plug of a cock in the tube E, and has a weight upon one end, in order that the other end may bear the valve up against the openings of the tubes F, G, with a considerable force, and also to support the weight of the small bucket I, which is suspended from the lever by a wire (at least when the bucket is empty); H is a small cistern to be filled with water from the reservoir A, in the same time that the water is raised up into D; this must be done by regulating the cock, k, upon the pipe which supplies the cistern with water. The cistern H is provided with a syphon, which will begin running as soon as the vessel is full of water, and will soon empty it. The small bucket I, which is suspended from the lever L, is also furnished with a syphon-tube, which will begin to run and empty the bucket whenever it is quite full, but not before.

The operation of the engine will be as follows:—The reservoir A being kept constantly full of water, and the conical tube B completely filled at its wider end by the water which runs out of A, the force of the lateral motion of the fluid will be increased by the conical form of the tube B, and will act upon the end of the tube E to draw air out of the same, so as to rarefy the air in the vessel D; and the pres-

sure of the atmosphere upon the surface of the water in the reservoir A, will cause part of that water to rise up the pipe C, to run over its top and fill the sphere D; it will then descend through E, and join the stream of water which flows out at B. When the vessel D is full of water, if the valve at the spout F is opened, the water will run out.

In order to open the valve the cock k is regulated, that the cistern H will be filled soon after D is full, and the syphon of this cistern beginning to empty the water it fills the bucket I, which then overbalances the weight upon the lever L, and opens the spout F, and air-pipe G, and at the same time closes the cock in E; the column of water in the descending pipe C immediately descends into the reservoir, and if the small tube G be full of water it will be emptied by the descent of that column, and will admit air into D so as to allow the water to flow out at F into the elevated reservoir. The syphon in the cistern H is regulated so that the cistern and the vessel D will be empty of water about the same time, and the bucket I by its syphon will become empty soon after: the weight upon the lever L will then close the spout F, and open the passage through E, when all the parts will stand as at first ready for a repetition of the operation of the lateral action of the stream, by which the water is raised up into D as before.

If the water should descend through E before F and G are opened, it will render the cock in E more tight. To quicken the reciprocation of the engine, and increase the quantity of raised water, a valve may be made to support the column of water in the suction-pipe; this valve may be placed in a chest at the bottom of the pipe.

The descending branch of the syphon in the higher vessel H should be made of considerable length, to prevent a constant dripping, and make the reciprocation end at once; the syphon of the bucket I should fall as large in bore as the other, in order that the weight on L may preponderate quickly, and close the valve immediately.

The inventor entertains no doubt respecting the operation of a machine of this kind, and that a column of water may be raised to any height not exceeding thirty feet by proportionally increasing the pressure of water in the reservoir, and the dimensions of the conical tube.

In many situations, however, the requisite quantity of water for this purpose cannot be had, and others may not admit of sufficient descent.

Where the stream has a considerable descent, the water may be raised by a number of lifts instead of one, by combining as many machines. Suppose three reservoirs each with its conical tube or spout through which the water runs from one to the other; also three exhausting vessels each with its elevated cistern into which the raised water is to be delivered; and the suction-pipe of each vessel draws its water from the elevated cistern of the vessel below it. From each exhausting vessel a pipe is conveyed to the conical spout of one of the three reservoirs, and the lateral motion of the stream passing through the spouts of the three reservoirs will act upon all three engines at once.

In like manner, when there is plenty of water, but not convenience for a deep reservoir, several conical spouts may be fixed to different parts of the reservoir, and all upon the same level. Each machine must be provided with a lever and weight to work its own valves, but they may be all opened at the same time by the descent of one vessel connected with all the levers, or each may have its respective bucket and syphons.

This kind of machinery, by altering the position of the rarefying tubes, may be made to raise water from a depth below the stream equally as well as to a height above it; and

in situations where there is plenty of water and convenience for a reservoir a lower body of water may be conveyed into a stream above by the help of a single tube, one end of which is placed in the water to be raised, and the other must be introduced into the smaller aperture of the conical tube adapted to the reservoir; a constant stream will then rise, so long as water below can supply the tube.

Mr. Whitehurst's Machine for raising Water by its Momentum.—Fig. 7, *Plate Water-works*, is a representation of the first machine on this principle, which was executed in the year 1772, by the ingenious Mr. John Whitehurst, at Oulton in Cheshire, at the seat of Mr. Egerton, for the service of a brew-house and other offices, and which purpose it was found to answer effectually. This first form of the momentum machine would be a useful application in many similar situations. The circumstances attending this water-work are as follow: A represents the spring, or original reservoir, which supplies the water, the upper surface coincides with the horizontal line BC, and the bottom of the reservoir K, into which the water is to be raised; D is the main-pipe, one inch and a half in diameter, and nearly two hundred yards in length; E, a branch-pipe, of the same dimensions, for the service of the kitchen-offices. It is to be observed, that the kitchen-offices are situated at least eighteen or twenty feet below the surface of the reservoir A; and that the cock F is about sixteen feet below it. G represents a valve-box, and *g* the valve within it; H is an air-vessel, and O, O, are the two ends of the main-pipe, inserted into the air-vessel H, and bending downwards, so that in effect the pipes communicate with the lowest part of the vessel, and the air cannot escape when the water is forced into it, but it must be compressed by the column of water; W is the surface of the water in the air-vessel. It is well known from theory that, when water is discharged from an aperture, under a pressure of sixteen feet perpendicular height, it will move at the rate of thirty-two feet in a second; the velocity of the water from the cock F will be nearly as much, making some allowance for friction and resistance; and although the aperture of the cock F is not equal to the diameter of the pipe D, yet the velocity of the water contained in the pipe will be very considerable; consequently when the cock is opened a column of water two hundred yards in length is put into motion, and if it is suddenly stopped by the shutting-cock F, its momentous force will open the valve *g*, and condense the air in vessel H; this action will be repeated as often as water is drawn from F. It is needless to say in what degree the air is thus condensed in the instance before us; but it will be sufficient to observe, that it was so much condensed as to force the water up into the reservoir K, and even to burst the vessel H, in a few months after it was first constructed, although it was apparently very firm, being made of sheet-lead, about nine or ten pounds weight to a square foot. Whence it is reasonable to infer that the momentous force is much superior to the simple pressure of the column in the reservoir K, above the level line CB, and therefore equal to a greater resistance (if required) than a pressure of four or five feet perpendicular height. It may be necessary farther to observe, that the consumption of the water in the kitchen-offices is very considerable, because water is frequently drawing from morning till night all the days of the year.

From this account which is published in the Philosophical Transactions for 1775, it is clear that Mr. Whitehurst was fully aware of the power of the momentum of running water, and though he applied it only to raise water to a small height, he knew it might be carried to a greater extent.

Montgolfier's Hydraulic Ram.—We have given the account of Mr. Whitehurst's machine, because it shews the first origin of a most valuable invention, which was afterwards practised in France by M. Montgolfier, the inventor of the first balloon with heated air. Mr. Boulton took a patent in England for Montgolfier's machine in 1797; he afterwards called his machine *belier hydraulique*, that is, hydraulic ram, because of the shock which the water makes when its motion is suddenly stopped. In his publication in the Journal des Mines, vol. xiii. he says, "This invention is not originally from England, but belongs entirely to France; I declare that I am the sole inventor, and that the idea was not furnished to me by any person. It is true that one of my friends, with my consent, sent to Messrs. Watt and Boulton copies of several drawings of this machine with a detailed memoir on its applications. These are faithfully copied in the patent taken out by Mr. Boulton in England, dated December 13, 1797, as that gentleman has avowed." We do not wish to detract from the merit of M. Montgolfier, as we believe that Whitehurst's machine was unknown to him, but we must state the hydraulic ram an English invention. To have an idea of this invention, it is proper to state its physical principle of action, which is as follows.

When water is running with a rapid current through a pipe or close channel, if the end at which the water issues be suddenly stopped, the water (by its acquired motion, momentum, or impetus,) will act upon the sides or circumference of the pipe, and endeavour to escape with a force proportioned to its quantity and velocity. If the materials of the pipe are strong enough to resist that impetus, the water may be made to issue with violence and velocity, at any aperture which is opened in or near the close end of the pipe; therefore if an ascending pipe be joined to that aperture, a portion of water will ascend in it. The machine being provided with proper valves, to prevent the return of the water so elevated, the operation may be repeated in a constant succession, and will form a kind of perpetual pump.

The same effect will be produced by a different arrangement of this apparatus, *viz.* a pipe open at both ends, with a valve and ascending-pipe, such as has been described. Let this be so attached to some kind of machinery, that it can be swiftly moved along, in the direction of its length, through standing water; then, upon closing the hinder part of the pipe suddenly, a portion of water will be forced up in the ascending-pipe, in the same manner as in the former case, and for the same reason, because the water will be relatively in motion with respect to the pipe.

The same principle may be readily extended to raise water by suction from a lower level than that on which the machine is placed, and this by either of the means above-mentioned. Suppose a suction-pipe, which communicates with water at a lower level, be joined to the main-pipe through which the water flows, and that the junction is near that end of the pipe where the water enters into it. Suppose also that the water has acquired a rapid motion through the pipe, either by the current of water running through the pipe, or by the pipe moving through the water; then let the mouth or end at which the water enters be suddenly shut by the machinery, and the water by its momentum will continue its motion relatively to the pipe, and will tend to exhaust the content of the pipe. This action will draw or suck up water through the ascending-pipe from the lower level, so as to fill up the vacuity in the main-pipe, occasioned when the water therein perseveres in its previous motion.

WATER.

The first and most simple hydraulic ram is shewn in section at *fig. 4.* (*Plate Water-works*); here C C represents the main-pipe, or body of the ram, through which the stream of current water is conducted; D, the ascending-pipe provided with a valve of exit at A, to allow the passage of the water which is raised, but to prevent its return; B is a stop-valve to close the end of the main-pipe; E is a balance-weight fixed upon the lever G, which communicates with another, K, attached to the axis of the stop-valve B; this weight tends to open the valve at the proper time. The main-pipe is to be situated in a current or stream of water, either produced by the natural current or declivity of a river or other stream, or by penning up the water by a dam or weir, and inserting the end of the main-pipe through the dam, so as to obtain the greatest fall of water which the natural circumstances will admit of. To put the machine in action, let the stop-valve be opened to the position shewn in the figure, the water will run through the main-pipe C, until it acquires a certain velocity which will be proportioned to the height of the fall of water which produces the current of water. The action of the current upon the stop-valve B, in its reclined position, will increase until it is sufficient to overcome the weight E, and then it will shut the stop-valve. The water being now suddenly stopped, and confined in the pipe C, by its impetus or momentum, will exert a considerable force within the pipe, which will open the other valve A, and a portion of the water will rise up the ascending-pipe D. The force of the momentum being expended in raising this water, the water in the main-pipe will immediately recover the equilibrium, and the closing of the valve A will prevent the return of the water which is raised in the ascending-pipe. The weight E now descends, and opens the stop-valve B, and the water in the main-pipe resumes its motion until its velocity is sufficient to close the valve A again, and the operation of raising the water is again repeated.

This water gradually rises in the ascending-pipe until it reaches its summit, and then a quantity will issue from it at every stroke into a proper reservoir R. The quantity will be more or less, according as the height to which it is raised, and to the velocity of the current, and the size of the apparatus. In this description, we have taken no notice of the action of the air-vessel J, at the bottom of the ascending-pipe D, although its use is very important to the practicability of the contrivance; for where the water is to be raised to any considerable height, the pipes, although formed of the best materials that can be procured, will be in danger of rupture from the great concussion of the water when suddenly checked; hence the rising of the water would be limited to the height of a few feet, or the pipes must be made of an extraordinary thickness, disregarding expence.

This danger of bursting the pipes is to be regarded in every case of applying this invention to practice; but it will be prevented, or very much diminished, by introducing an air-vessel I. The water from the main-pipe enters at every stroke through the exit-valve A, and compresses the air in the vessel J, which again, by its expansion or elasticity, acts upon the water, (which is prevented from returning to the pipe C by the shutting of the exit-valve,) and therefore rises through the ascending-pipe, and by repeated strokes acquires the desired height.

The dimensions of the air-vessel, as well as its form and position, and whether it is affixed to the main-pipe laterally or above, are in a great measure arbitrary; but its contents of air ought not to be much less than ten times the quantity of water to be raised through the ascending-pipe at each

stroke, and if very much larger still the better, the principal boundary being expence.

The regulation of the stop-valve B, is a principal point in the construction of these machines. It may be opened and shut by the current, as has been described, in a very simple manner, by adapting the valve to move upon an axle or hinge, and assisting it to open at the proper time by a weight attached to a lever fixed to its axis at the proper angle. The valve should be prevented from opening to such a degree, that the action of the current of water could not shut it. This must be done by some fixed resistance behind the valves, as shewn at B, *fig. 3.*, or by any other convenient means.

It is necessary to adjust the weight by experiment, so as to open the valve at the right time, according to circumstances, which may be done either by sliding the weight nearer to, or farther from, the centre of motion, or by increasing or diminishing the weight itself. The inconvenience of this method is, that the weight being generally under water, it is troublesome to adjust it; therefore the mechanism shewn in *fig. 4.* is better adapted to the stop-valve. The weight E is fitted upon a lever connected with a spindle, to which another arm or lever G is also fixed, and that is connected by rod *a*, with the arm K fixed to the valve.

The rod may be prolonged to any necessary length, and the weight and its mechanism may be always placed above water, so as to be easily come at for adjustment. Valves of this kind may be hinged either upon their lower or upper edge, or upon one of the perpendicular sides as a common door, as convenience requires, and the mechanism is connected accordingly.

When it is required to open the stop-valve so completely that the current of water in the main-pipe cannot act upon it, to shut it, a small stream of water is led from the head, which supplies the main-pipe, or from some other source into a pipe or trough, which is furnished with a cock to regulate the quantity. This pipe or trough pours its water into the bucket G, *fig. 5.*, which causes the bucket to preponderate, and by means of the lever *bc*, fixed to its axle, and the rod *cd* attached to it, it shuts the stop-valve B, by the connection of the lever *de* attached to it. The bucket then empties its water, and the pendulous weight E, as soon as the recoil of the water in the main-pipe takes place, preponderating in its turn, opens the valve, and restores the bucket to its place. In this contrivance, by opening the cocks of supply more or less, and by adapting the capacity of the buckets in proportion to the weight E, the number of strokes to be made in any given time is regulated.

The stop-valve may be constructed in a circular form, and, instead of being hinged upon one side, may be fixed upon a spindle in its centre, which slides in a socket, similar to what are called button-valves used in pump-work, and at the proper time is opened by mechanism similar to the former; or, in place of the weight, a spring may be employed.

In constructing large machines, where the shock, from shutting the stop-valve, might endanger the derangement of the machine, other kinds of stop-valves will be preferable to those before described.

A very good form of valve is that which opens in two leaves, like the gates of a canal-lock. The leaves may shut one upon another in the middle, or may shut upon an upright bar placed there. They are opened by the same kind of mechanism as we have described before, only there must be two connecting-rods, one to each leaf of the valve; and these

these being united together, will cause them to shut both together. The aperture for this valve is of a rectangular form.

A valve in two leaves, such as is called a butterfly-valve, may also be hinged in the middle of the opening, but would too much obstruct the water-way. When the main pipe is of a large diameter, (for instance, two feet or upwards,) the stop-valve may be made in three, four, or more leaves connected together by mechanism, similar to Venetian window-blinds.

Another kind of valve is poised upon an axis, like a common fire-stove chimney damper; the axis does not pass through its centre, but divides it into two unequal segments. The valve is not opened so far as to stand in the line of the current of water, but, when opened, stands inclined to that current; so that the larger segment being placed towards the stream, the latter may by its action shut it at the proper time. It is opened by mechanism similar to the former. Another kind of valve is a spherical ball of porcelain, which is fitted into a seat.

When the machine is made use of in an open river, which does not admit of having its water penned up by a weir or dam-head, the main pipe ought to be laid so as to be covered by the low waters of the river; and it ought to be parallel to the surface of the river, so as to have the greatest possible declivity that can be obtained in the length of the main pipe: its mouth or receiving end should be shaped like that of a trumpet or bell. In all cases whatsoever, the valves ought to be completely under the surface of the water, in the lower reservoir.

*Performance of the hydraulic Ram, (see RAM).—*M. Montgolfier, in his publication, says, that a belier hydraulique, executed with care, is capable of rendering three-fourths of the force which is employed to move it, that is, the product of the weight of water raised, multiplied by the height to which it is raised, will be equal to three-fourths of the product of the weight of water which works the machine, multiplied by the height of the fall. Commonly it yields six-tenths, but he would only engage to furnish half. Thus, if the water was to be raised 100 feet by a fall of 5 feet, he would engage to make a machine which should deliver at 100 feet a fortieth part of the whole quantity which fell. He recommends particularly that the machine should be fixed in the most solid manner, by masonry or timber, so that the shock of the water can produce no motion of the machine, because all such motion will deduct considerably from the quantity of water raised. It is stated that the machine will make from 20 to 120 strokes *per* minute.

The dimensions of an hydraulic ram at the bleaching works of M. Turquet, near Senlis, in France, when reduced to English measure, are as follow: diameter of the body of the ram 8 inches, fall of the water 3 feet 4 inches, height to which the water is raised 15 feet 1 inch. In three minutes this machine made 100 strokes, which expended 67 cubic feet of water, and raised $9\frac{1}{4}$ cubic feet: hence, $67 \text{ cubic feet} \times 3\frac{1}{4} \text{ feet} = 223$, and $9\frac{1}{4} \text{ cubic feet} \times 15\frac{1}{7}$

feet = 140. Now $\frac{140}{223}$ is equal to $\frac{6.3}{100}$ ths, so that the

effect produced is above six-tenths of the power applied. In another experiment it was found to be 64-hundredths. This machine raised a quantity of water equal to 6.2 inches of water (pouces de fontanier), for 269 litres which are nearly equal to 280 pints, in three minutes; and the pouce de fontanier is a measure of running water equal to 14 pints (French) *per* minute, or 796.37 cubic inches, English. This ma-

chine working 24 hours will raise 134400 pints (French), or 4512 cubic feet English, of water to a height of 15 feet 1 inch. The water raised by this machine is equal to $\frac{3}{4}$ the power of a man, according to our standard.

M. Montgolfier recommends the pipe or body of the ram to be of an equal diameter through the whole length; and all internal irregularities are to be avoided, because they diminish the velocity of the water: the strength of the pipe should be at least equal to sustain a column of twice the height to which it is intended to raise the water.

He says, that he executed one with a fall of 10 feet, which compressed the air in an air-vessel to an equal degree with 40 atmospheres, which, taking the pressure of the atmosphere equal to 33 feet of water, makes the pressure equal a column of water 1320 feet in height.

Improved hydraulic Ram.—M. Montgolfier, the son of the inventor, has recently obtained a patent in England for an improved hydraulic ram, in which, by attention to some minute particulars in the construction, he is enabled to make the length of the tube much less than in the former machines; and he has even obtained a result equal to 84 *per cent.* of the power employed.

One of these improvements is the addition of a small snifting-valve, which, at each movement, serves to introduce a small quantity of air into the head of the ram, from whence it is driven by the next movement into the air-vessel, which would otherwise become filled with water, if the air, absorbed by the contact of the water under a strong pressure, were not continually replaced by some such means.

Also, in the interior of the head of the ram is an annular space, furrounding the frame of the stop-valve: this contains a small volume of air, which cannot be forced into the air-vessel, but which, at each movement, is compressed by and receives the first effort of the moving water. This he calls the air-matras, and by means of it, the shutting of the stop-valve makes less noise, the pipe is not strained, and all the operations take place with so much ease, that the machine is less shaken, and less frequently out of repair. The following is a description of the new machine.

That end of the pipe or body of the ram which receives the water of the reservoir is formed like a trumpet-mouth, that the water may flow more readily into the pipe; and the length of the pipe must be regulated according to the height of the fall of water, which is to produce the current through it. The pipe is composed of several pieces or lengths screwed together by flanges, or other similar means; but it is in the end piece, which is called the head of the ram, that the moving parts of the machine are placed.

The extremity of the pipe or head of the ram is a hollow sphere, the diameter of which is nearly twice as great as the bore of this pipe: the upper part of the spherical end is flattened, so as to reduce it to a segment of a sphere, with a flat circular surface on the top or upper side, in the centre of which surface is a large circular opening to receive and hold the seat of the stop-valves, at which the water issues; but when the valve is closed, it prevents the water from issuing.

When the valve opens, it descends perpendicularly into the hollow sphere, and leaves a free passage through the opening. Its motion is guided between three or four perpendicular stems, which have hooks formed at the lower ends to retain or support the valve when opened; and these stems are fixed by screws, so that they can be regulated to allow the valve to descend more or less, and open a greater or less passage for the water. The valve is made of metal, and hollow, for it has a flat circular plate of metal, with a hollow cup or dish of metal attached to its lower surface:

this at the same time renders the valve lighter in the water, and gives it a convex surface on the lower side, which, when the valve is opened, corresponds in curvature with the interior concave surface of the spherical end of the head of the ram. The seat of the valve is composed of a short cylinder or pipe, of which the opening is much greater than the transverse section of the body of the ram. This short cylinder is screwed by its flanch into the opening in the upper surface of the head of the ram. This flanch of the seat is so formed as to have an inverted cup round the upper part of the short cylinder, that is, a circular channel or annular space within the head of the ram, which will contain air, and from which the air cannot escape when the water compresses. The air in this channel is called the air-matras.

The snifting-valve is at the end of a small pipe, which leads from the annular space or matras to the open air. The snifting-valve opens inwards, in order to admit the air to enter into the matras; but to prevent its return, there is another small valve in the same pipe, which opens outwards: the office of this is to admit a certain quantity of air into the matras, and then to shut and prevent any farther entrance.

On the outside of the seat of the stop-valve that is over the aperture in the head of the ram, where the water issues, another stop-valve is applied, which is similar to the internal valve before mentioned, but shuts down on the outside of the seat. Its use will be hereafter explained.

The upper part of the pipe or head of the ram is made flat at the part near the end where it enlarges to a sphere; and this flat surface on the top of the pipe has several narrow openings across it, which are covered by as many flap-valves of leather, to allow water to pass out from the main pipe, but to prevent its return. And on each side of the head of the ram, at the part opposite to these flap-valves, is a hollow enlargement, in form of a segment of a horizontal circle; and the two enlargements taken together form a circular basin, through the centre of which the pipe of the ram passes; but, as before stated, the pipe, instead of being circular, is flat at top at that part, to form the seats for the flap-valves. This circular basin is covered by a cylindrical air-vessel, screwed down by means of a flanch at the edge, so that the circular basin forms the bottom of the space in the air-vessel; the flap-valves being covered by the air-vessel are therefore within the vessel.

In consequence of this arrangement, all the water which issues from the body of the ram through the flap-valves will flow off on each side, and be received in the basin; but as the circular basin or bottom of the air-vessel is divided into two parts, by the pipe of the ram which passes through it, there is a passage communicating from one of the enlargements to the other; for which purpose, it curves down and descends beneath the pipe of the ram; and the ascending pipe that carries away the water which the machine raises, proceeds either from this curved passage or from some other part of the basin, so that it may receive the water which has passed from the body of the ram through the flap-valves and the air-vessel into the basin, at each side of the pipe.

The action of this hydraulic ram is nearly the same as the preceding. Suppose the pipe or body of the ram is full of water, if the internal stop-valve is opened, the water from the reservoir will flow through the body of the ram, and issue through the opening at the end, it will lift up the external stop-valve and escape; but the current having continued until the water has acquired a certain velocity, the force of the current buoys up the internal valve, and closes

the passage. The motion of the water contained in the ram will thus be suddenly arrested, and by its *vis inertia*, or moving force, will exert a sudden pressure against the stop-valve, and against all the interior parts of the ram. The small quantity of air contained in the space around the interior stop-valve, which is called the air-matras, is compressed into a smaller space, and, by its elasticity, takes off the violence of the shock or blow which would otherwise be produced. This pressure opens the flap-valves on the top of the pipe, which are within the air-vessel, and a portion of the water will be driven into the air-vessel, which is supposed to be full of air, compressed or condensed, till its elasticity equals the pressure of the column of water which is to be raised up the ascending pipe by the action of the machine.

The water which is forced into the air-vessel causes the air therein to be condensed, and to exert a greater degree of elasticity, until it will exceed the pressure of the column of water in the ascending-pipe; by degrees this air will therefore force through the said pipe all the water which was injected through the flap-valves, and cause that quantity of water to issue from the upper extremity of that pipe.

The moving force, or *vis inertia* of the mass of water, which was in motion in the body of the ram, having expended itself by forcing a portion of water into the air-vessel, and making a still greater compression of the contained air, a recoil of the water in the body will take place with a slight motion from the valve towards the open end of the body; this arises from the reaction or elasticity of the air contained in the air-matras, and also of the metal of which the tube is composed.

The flap-valves within the air-vessel shut, and prevent the return of the water which has been forced into the air-vessel. This recoil of the water in the body towards the open end causes a slight aspiration within the whole body of the ram, and the external stop-valve descends by its weight, and prevents the water with which it is covered from entering through it; but the air passes through the small pipe, leading from the open air to the annular space or air-matras, and opens the snifting-valve, and a small quantity of air is sucked into the matras; but this is a very small quantity, because the external air-valve closes as soon as the air flows with a rapid current through the pipe and snifting-valve.

During the recoil, the internal stop-valve having nothing to sustain falls by its weight, and opens the passage; and as soon as the force of the recoil has expended itself in acting against the column of water contained in the reservoir at the open end of the body, the water begins again to flow through the body in its original direction, and repeats the action before described.

It shuts the internal stop-valve when it has acquired the intended velocity, and being thus stopped, the efflux of the *vis inertia* condenses the air-matras, and opening the flap-valves, forces a quantity of water into the air-vessel, from which the reaction of the contained air will drive it up the ascending-pipe.

The *vis inertia* of the moving column of water being thus expended, the recoil commences by the reaction of the air in the matras, the flap-valves shut, and the external stop-valve likewise; the aspiration produced by the recoil draws some air through the snifting-valve, and it joins the air in the matras. The internal stop-valve falls open by its weight and opens the passage, so that the water in the pipe can resume its motion when the recoil has exhausted itself.

The small quantity of air which is drawn into the machine through the air-valve, at each aspiration, causes an accumulation

cumulation of air in the matrafs; and when the aspiration of the recoil takes place, a small quantity of this air passes from the annular space, and proceeds along the pipe till it arrives beneath the flap-valve, and lodging in the small space beneath these valves, it will be forced into the air-vessel at the next stroke, by which means the air-vessel is always kept filled with air.

The following are the dimensions of a machine which is calculated to raise water up the tube to 100 feet above the surface of the water in the reservoir, when the fall by which it is worked is five feet, that is, where the level of the water in the reservoir is five feet above the lower level; and the length of the pipe from the open end to where the water is discharged is to be twenty feet long, and six inches in diameter.

Such a machine may be expected to expend about seventy cubic feet *per* minute to work it, and to raise up about two and one-third cubic feet *per* minute; but these quantities cannot be exactly stated, because they depend upon the care and accuracy with which the machine is constructed. Under different circumstances, having a greater or less fall or quantity of water, the dimension of the machine must be calculated accordingly.

The improvements in this last form of the hydraulic ram are,

First, that by constructing the head of the ram with the upper side of the pipe flat, and applying the flap-valves immediately upon the top, there is very little space to contain dead water, that is, water which will be motionless when the current takes place in the pipe; and by dividing the single valve of the original machine into several small and narrow valves, they open and shut more suddenly, and with less loss of water.

Secondly, in making the basin on each side of the pipe, which basin is on a lower level than the flap-valves. By this means the water will flow off from the flap-valve on each side, and at the instant when the machine performs its stroke, and forces water through the said valves into the air-vessel, the valves will not be covered, or at least very slightly covered by water; consequently, when those valves open, and the water is forced into the air-vessel, it has only the compressed air to oppose it, which from its elasticity allows the water to enter with more facility than if it was resisted by a column of water resting upon the valves; not that there is any less hydrostatic pressure upon the valves, because it is the air which bears upon them, instead of the water, but there is a less mass of matter to be put in motion by the water which enters into the air-vessel: for it has only the matter contained in the valves themselves to put in motion.

Thirdly, in applying the external stop-valve, the use of which is to prevent the water returning into the ram when the recoil takes place, and having this provision, a greater quantity of air can be employed in the matrafs than could otherwise conveniently be done; this renders the shock which takes place when the stop-valve is shut less sudden. We have examined several of these machines made in France by the inventor, and can with confidence recommend them to engineers as the very best machine, and the most simple for raising water when there is a natural fall. The last improvements, as they enable us to shorten the length of the body of the ram to nearly one-third, without reducing the performance, are very important.

The hydraulic ram is adapted to give motion to the hydrostatic presses, which are in common use under the name of Bramah's presses. For this purpose, it is only necessary to apply the ascending-pipe to the cylinder of the hydraulic press, and at each stroke of the ram a small quantity of

water will be forced or injected into the cylinder of the press, and will thus produce the ascent of the piston of the press in the same manner as is now performed by the small injection-pump worked by the force of men. But by the application of the hydraulic ram to that purpose, the press can be worked in any situation where there is a small fall of water, and the ram may be set in motion whenever the press is wanted.

An *Hydraulic Ram*, or *Momentum Machine acting by Suction*, is shewn at *figs. 2 and 3, Plate Water-works*. This is applicable in cases where the water to be raised is below the level of the main-pipe, and is to be discharged at that level; a case which frequently occurs in the drainage of marshy lands, where the action of the current of water, in an embanked river, or other stream or source of water on a higher level, can be employed; or this method can be applied in raising water out of the holds of ships by the motion of the vessel through the water; also to raise water out of a well of moderate depth.

C represents a portion of the main-pipe; B, *fig. 2* is the stop-valve situated at the entrance of the pipe, and opening outwards so as to stop the passage of the pipe when it is shut; D, the ascending or sucking-pipe, communicating with the well at the bottom and with the main-pipe at the top; J is the air-vessel; and E the weight of the stop-valve of the main-pipe. There is likewise a valve A opening from the air-vessel into the main-pipe.

The water in the main-pipe having acquired a proper velocity by the current, as in the former cases, the stop-valve B shuts, and the water in the main-pipe continuing its motion for a time, draws air out of the air-vessel J, through the valve A. The momentum of the water in the main-pipe being soon expended it recoils, the receiving-valve A shuts to prevent the return of the water into the air-vessel, and the stop-valve B opens by the action of the weight E, the water thus regains its passage, and soon acquires sufficient velocity to close the stop-valve again, and the operation is repeated.

Thus in a few strokes the exhaustion is increased till the air-vessel sucks up water from below, through the ascending-pipe D, or rather the pressure of the atmosphere on the surface of the valve below forces it up, when the pressure on the surface within the air-vessel is removed by the exhaustion. This action being continued, the ascending-pipe fills by degrees to the top, after which, at every successive stroke, a portion of the water from below passes into the main-pipe, and is carried off into the pipe C, where it mixes with the upper water.

In cases where the water of the tide or other alternating current is employed as the motive power, the apparatus may be constructed in two ways, either by applying a stop-valve, air-vessel, and ascending-pipe, such as is shewn at one end in *fig. 4*. to each end of the main-pipe C, to be used alternately, according as the tide sets in the one direction or the other; or otherwise by applying two main pipes to one air-vessel, their mouths being placed in opposite directions and to be used alternately, and applied to the raising of water, for the use of salt-works, or for other uses, such as the supply of a country-house.

The first machine above described may be employed to raise water to small heights by the motion of the waves of the sea, or of any large pieces of water; in which case the mouth or receiving end of the main-pipe should be formed like a speaking-trumpet, as shewn in *fig. 4*. and placed opposite to the direction in which the waves beat upon the shore at the place where the machine is. The water of the waves will enter the main-pipe, and rush through it until the

the stop-valve shuts; when the contained water will in part enter the air-vessel by the action already described, and the next wave will produce another stroke.

Momentum-Pump, or Momentum-Machine, to raise Water by the Application of mechanical Power.—Where a fall of water cannot be obtained, *fig. 1.* shews an application of this momentum principle, in lieu of pumps for raising water, the main-pipe being put in motion through the water by the strength of men, or other mechanical power in default of a current, as in the other cases.

CC is the main-pipe bent in a spiral form round the air-vessel J; it may either be made to touch it, or be kept at a distance from it, and may make one or more revolutions round the said vessel; the whole of the main-pipe is immersed in the external water which is to be raised. Both ends of the pipe are open to the water; but one of them has the stop-valve opening inwards, which will occasionally close it, and near this latter end, a communication is made by a side-pipe with the air-vessel, the orifice being covered by a valve opening into the vessel. The whole turns upon a pivot K, at the lower end of the ascending-pipe D, which serves as an axis, and is kept upright by a collar, in which it turns, as shewn at L. Upon this axis a toothed wheel M is fixed, and is put in motion by another wheel N, turned by a winch, crank, or other contrivance.

At the top, or upper end of the ascending-pipe, the water is discharged into a trough, which surrounds it, and conveys it to the place of its destination.

This apparatus is made to raise water by a continued rotatory motion, the open end moving first, through the water which passes out again through the other end; but whenever, by that motion, the main-pipe has attained a proper velocity, the stop-valve shuts suddenly, and by the concussion the water passes into the air-vessel, from whence the egress of the water is prevented by the shutting of the exit-valve. The stop-valve then opens by means of a spring in lieu of a weight, as in the former cases, and the apparatus continuing to revolve in the same direction, more strokes are made at intervals proportioned to the velocity with which it moves. The spring of the stop-valve should be so regulated in force as to allow the relative motion of the water in the main-pipe to shut the stop-valve at proper intervals. The perpendicular section of the main-pipe is drawn square, but may be circular, or of any other convenient figure. A horizontal section of it is shewn at *fig. 6.* with the main-pipe and the air-vessel.

In lieu of the wheel N, which produces a continued rotatory motion, the machine may be made to vibrate or swing upon an axis, backwards and forwards, the limits of the vibration or stroke being determined by a detent striking against a stiff spring. In this case, the main-pipe should be provided with stop-valves at both ends, and also have a communication at each end with the air-vessel, which openings should be closed by valves to prevent the return of the water from it. Such a machine may be put in motion by the following means: upon the ascending-pipe D, a double pulley is fixed, round which are wound the ropes, and by pulling the ends of these alternately, the apparatus may be made to revolve in either direction. The main-pipe and the ascending-pipe being filled with water by hand or otherwise, if the ropes are pulled alternately, they will make the pipe move through the water with sufficient velocity to make the apparatus act. It is found if the apparatus makes about thirty vibrations in each minute, that it will act very completely.

Hydraulic machines are of the greatest importance to society, whether we look to a supply of the first necessity

for domestic uses, or to the advantageous uses of neglected though valuable first movers. These machines must, in most cases, be modified by localities, and other circumstances; and consequently the most useful practical knowledge will not consist in any acquaintance with one or more of the best engines, but with that great variety of happy contrivances which inquiry and reflection must point out. We have, as far as our limits permit, given all the machines which are practically useful, and we shall conclude this article by giving Dr. Young's catalogue of the most important and valuable writings on hydraulic engines.

Ramelli's Collection of Hydraulic Machines, in French and Italian, 1588, folio.

Descriptio Machinæ Hydraulicæ curiosæ Constructa, Joh. Georg. Faudieri, Venet. 1607.

Bates on Art and Nature, 1635.

Nouvelle invention de lever l'eau plus haut que la source avec quelque machines mouvantes par le moyen de l'eau, &c. par Ifac de Caus, 1657.

Josephi Gregorii a Monte Sacro Principia physico-mechanica diversarum machinarum seu instrumentorum pneumatica ac hydraulica, Venet. 1664.

Nouvelle Machine Hydraulique, par Francini Journ. des Scav. 1669.

[An account of this machine is likewise given in the Architecture Hydraulique of Belidor, tom. ii.; and in the 2d vol. of Defaguliers' Experimental Philosophy: in both which performances many other hydraulic machines are described.]

An Undertaking for raising Water, by Sir Samuel Moreland. Phil. Transf. 1674. N° 102.

An Hydraulic Engine. Phil. Transf. 1675. N° 128.

A cheap Pump, by Mr. Conyers. Phil. Transf. 1677. N° 136.

M. de Hautfeuille, Reflexions sur quelque Machines à élever les eaux, avec sa description d'une nouvelle pompe, sans frottement, et sans piston, &c. 1682.

Elevation des eaux par toute sorte de Machines, reduite à la mesure, au poids, à la balance, par le moyen d'un nouveau piston et corps de pompe, et d'un nouveau mouvement cyclo-elliptique et rejetant l'usage de toute sorte de manivelles ordinaires, par le Chevalier Morland, 1685.

A new Way of raising Water, enigmatically proposed by Dr. Papin. Phil. Transf. 1685. N° 173. The solutions by Dr. Vincent and Mr. R. A. in N° 177.

M. du Torax, Nouvelles Machines pour épuiser l'eau des fondations, qui, quoique très simples font un effet surprenant, 1695. Journ. des Scav. 1695. p. 293.

An Engine for raising Water by the help of Fire, by Mr. Thomas Savery. Phil. Transf. 1699. N° 253.

D. Papin nouvelle maniere pour lever l'eau par la force du feu; à Cassel, 1707.

Memoire pour la construction d'une pompe qui fourni continuellement de l'eau dans le reservoir, par M. de la Hire, Mem. Acad. Scien. Paris, 1716.

Description d'une machine pour élever des eaux, par M. de la Faye, Mem. Acad. Scien. Paris, 1717.

Joh. Jac. Bruckmann's und Joh. Heindr. Weber's Elementar-maschine oder universal-mittel bey allen wasser-hebungen. Cassel, 1725.

Jacob Leopold, Theatri machinarum hydraulicarum, 1724 et 1725.

Joh. Frid. Weidleri tractatus de machinis hydraulicis toto terrarum orbe maximis Marlyensi et Londinensi, &c. 1727. Vide Act, erudit. Lipf. 1728.

A Description of the Water-works at London-bridge, by H. Beighton, F. R. S. Phil. Transf. 1731. N° 417.

An account of a new engine for raising water, in which horses or other animals draw without any loss of power (which has never yet been practised); and how the strokes of the piston may be made of any length, to prevent the loss of water by too frequent opening of valves, &c. by Walter Churchman. Phil. Trans. 1734.

Sur l'effet d'une machine hydraulique proposée, par M. Segner, par M. Leon. Euler. Mem. Acad. Scien. Berlin, 1750.

Application de la machine hydraulique de M. Segner, à toutes sortes d'ouvrages et de ses avantages sur les autres machines hydrauliques, par M. Leon. Euler. Mem. Acad. Scien. Berlin, 1751.

[M. Segner's machine is no other than the simple yet truly ingenious contrivance known by the name of Barker's-mill, which has been described in the 2d volume of Defaguliers' Philosophy, some years before the German professor made any pretensions to the honour of the invention. The theory of it is likewise treated by John Bernouilli at the end of his Hydraulics.]

Recherches sur une nouvelle manière d'élever de l'eau proposée, par M. de Mour, par M. L. Euler. Mem. Acad. Berlin, 1751.

Discussion particulière de diverses manières d'élever de l'eau par le moyen des pompes, par M. L. Euler. Mem. Acad. Berlin, 1752.

Maximes pour arranger le plus avantageusement les machines destinées à élever de l'eau par le moyen des pompes, par M. L. Euler. Mem. Acad. Ber. 1752.

Reflections sur les machines hydrauliques, par M. le Chevalier D'Arcy, Mem. Acad. Scien. Paris, 1754.

Memoires sur les pompes, par M. le Chevalier de Borda, Mem. Acad. Scien. Paris, 1768.

Dan. Bernouilli, Expositio theoretica singularis machinæ hydraulicæ. Figuris helvetiorum exstructæ. Nov. Com. Acad. Petrop. 1772.

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Recherches sur les moyens d'exécuter sous l'eau toutes sortes de travaux hydrauliques, sans employer, aucun epuise-ment, par M. Coultomb. 1779.

Saemund Magnussen, Holm, Efterretning om skye pumpe Kiøbenhavn, 1779.

Moyen d'augmenter la vitesse dans le mouvement de la vis d'Archimede sur son axe, tire des mémoires manuscrits de M. Pingeron, sur les arts utiles et agréables. Journ. d'Agric. Juin. 1780.

The Theory of the Syphon, plainly and methodically illustrated, 1781. (Richardson.)

Memoria sopra la nuova tromba funicolare umiliata, dal. Can. Carlo. Castelli. Milano, 1782.

Dissertation de M. de Parcieux sur le moyen d'élever l'eau par la rotation d'une corde verticale sans fin Amsterdam et Paris, 1792.

Theorie der Wirzichen spiral pumpe erlaütert von Heinr. Nicander, Schwed, Abhandl. 1783.

Jac. Bernouilli, Essai sur une nouvelle machine hydraulique propre à élever de l'eau, et qu'on peut nommer machine pitotienne. Nov. Act. Acad. Petrop. 1786.

K. Ch. Langsdorf's Berechnungen über die vortheilhæftere benutzung angelegter sammelteiche zur betreibung der maschinen. Act. Acad. Elect. Mogunt, 1784, 1785.

Nicander's Theorie de spiral pumpe, 1789.

Nouvelle architecture hydraulique, par M. Prony, 1790, 1796.

A short account of the invention, theory, and practice of fire-machinery; or introduction to the art of making ma-

chines, vulgarly called steam-engines, in order to extract water from mines, convey it to towns, and jets d'eaux in gardens, to procure water-falls for fulling, hammering, stamping, rolling, and corn-mills, by William Blakey, 1793. Egerton.

Machines actuated by the Force of Currents or Streams of Water.—These are very numerous, but all may be reduced to two kinds.

First, those which are adapted to receive the impulse of moving water; that is, water which has been put in motion in consequence of a descent towards the earth previously to its operating on the machine, which must be provided with parts proper to resist and take away some of the motion of such water, and it will thereby receive motion which may be applied to produce some mechanical effect. Of this kind are undershot and horizontal water-wheels.

Secondly, those machines which are provided with some kinds of buckets or vessels to contain water, the weight of which buckets, and the water they contain, is supported by the machine, so that the water cannot descend towards the earth in consequence of its gravitation, without giving motion to the buckets or vessels which contain and support it. Of this kind is the over-shot water-wheel, breast-wheel, chain of buckets, and pressure-engine.

In either case, the motive force or power is the same; viz. the gravitation and motion of such bodies or masses of water as are found more elevated above the surface of the earth than the general level of the sea, or of some other water in its neighbourhood; such water will descend by the force of gravity until it joins the sea, or until it is supported or held up by some fixed obstacle.

The difference between the two kinds of machines is, that in the first case the water is suffered to descend before it operates upon the machine, and in consequence of its gravitation, acquires motion with a velocity proportioned to the space through which it has descended; and the office of the machine is to take from the moving water as much of its compounded weight and motion, or power, as it can obtain.

In the other case, the machine receives its motion and power at the same time, when the water acquires it, by descending; or, in other words, the machine moves with the water.

The word *power*, as used in practical mechanics, signifies the exertion of strength, gravitation, impulse, or pressure, so as to produce motion; and a machine actuated by means of strength, gravitation, impulse, or pressure, compounded with motion, is capable of producing an effect: and no effect is properly mechanical but what requires such a kind of power to produce it.

The muscular power of animals, as likewise pressure, impact, gravity, electricity, &c. are looked upon as forces, or sources of motion; for it is an incontrovertible fact that bodies exposed to the free action of either of these are put in motion, or have the state of their motion changed. All forces, however various, can be measured by the effects they produce in like circumstances; whether the effects be creating, accelerating, retarding, or deflecting motions: the effect of some general and commonly observed force is taken as unity.

The most proper measure of power is the act of raising some weight with some velocity of motion; that is, the overcoming of the gravitating force of a weight in such degree as to produce motion in opposition to gravity. In considering the quantum, the weight or mass of matter operated upon must be one quantity, and the velocity of the motion communicated is the other; the mechanical power is the

the compound of both. We can only measure the weight of any body or mass of matter by its relation to some other weight with which we are acquainted; hence we say, the weight is equal to so many pounds, or so many cubic feet of water. In like manner, we measure the velocity or intensity of the motion, by stating the height or perpendicular distance from the earth, (measured by relation to some known distance, as a foot or a yard,) through which height the weight is raised in some known space of time, as a second or a minute.

For instance, 528 cubic feet of water is a known weight or mass of water: let a machine operate upon this, and raise it upwards, through the space of one foot in the time of one minute; then $528 \times 1 \times 1 = 528$ is the number which represents the power which the machine exerts. Suppose another machine to operate on 132 cubic feet of water, and raise it four feet in one minute, then using the same measures to determine the quantities of weight, height, and time, we say $132 \times 4 \times 1 = 528$; hence these two machines are equal in the power which they exert; for in all cases the weight raised is to be multiplied by the height to which it can be raised in a given time, and the product is the measure of the power expended in raising it; consequently, all those powers are equal whose products made, by such multiplication, are equal; for example, take two powers, if one can in any given time raise twice the weight to the same height, or the same weight to twice the height, in the same time that the other power can, the first power is double the second; or, if one power can raise half the weight to double the height, or double the weight to half the height, in the same time that another can, those two powers are equal: but note, all this is to be understood only in cases of slow or equable motion of the body raised, for in quick, accelerated, or retarded motions, the *vis inertia* of the matter moved will make a variation.

The machines actuated by the impulse of flowing water are, the undershot water-wheel, horizontal wheels, and Dr. Barker's mill. It is a common expression to call all wheels in which the water runs or shoots under the wheel, undershot; but in this place we shall only speak of

Undershot Water-Wheels, acting by the Impulse of flowing Water.—These are the most ancient and original forms of water-machines, although if they had been invented from the result of reasoning, such as we have given, they would have been the last, because their manner of action is less obvious; but this was not the case. The first machines were wheels placed in a river or running stream, and provided with vanes or wings on the circumference, called floats; the floats at the lower part of the wheel, dipped into the stream to intercept the water. When the plane of the floats became perpendicular to the direction of the current, or nearly so, they would resist or oppose the motion of the water, and the wheel would obtain motion from it in proportion to the quantity of motion, its floats abstracted from the water of the stream. The power thus obtained would be found to be only a small proportion of the power of the stream, because the water would easily escape sideways from the floats, particularly if it were attempted to take away any considerable share of the velocity of the water, by resisting or loading the wheel, so as to make it move slowly. Hence it became an obvious improvement to contract the river to the exact size of the float-boards of the wheel, or to make a close channel in which the wheel exactly fits. The next improvement would be to intercept the river or stream of water by a dam, or obstacle, in order to make it pen up, or accumulate, till it had risen to the greatest height which could be obtained, and to let the water out of the dam or

reservoir into the channel or wheel-course, through a vertical aperture or door, level with the bottom of the wheel-course; in this way, the water would be urged by the pressure of the water in the dam, and would rush out from the aperture in a stream or spout, with a velocity proportioned to the perpendicular pressure, and would strike the float-boards of the wheel so as to urge them forwards. Such is the form of the undershot wheels still generally employed in France and on the continent; but in England they have been long superseded by more effectual applications of the power of the water, and it is very rarely we meet with an undershot wheel acting by the impulse of the water. They are called ground-shot wheels, because the water runs or shoots along the ground or floor of the channels in which the wheels work.

It was first proved by Mr. Smeaton, in 1754, that only a portion of the power of any fall of water could be obtained by means of an undershot wheel; for M. Belidor had not long before stated the undershot wheel as the best mode of applying a fall of water. It was one of the continual occupations of Mr. Smeaton, during forty years, to improve the old water-mills, by substituting breast-wheels for undershot; and the advantages were uniformly so great, that these mills were copied by others, until scarcely any of the original construction remained. We do not mean that Mr. Smeaton invented the breast-wheel, for it is described by Leopold; but he first investigated its comparative advantages.

It is from this circumstance that we find, in all the mechanical writings of foreign authors, much more mathematical investigation relative to the undershot water-wheels than the importance of the subject deserves, and we shall dismiss it more briefly.

The excellent paper by Mr. Smeaton, in the Philosophical Transactions for 1759, contains a numerous list of experiments most judiciously contrived by him, and executed with the accuracy and attention to the most important circumstances which are to be observed in all that gentleman's performances.

Mr. Smeaton's rules were originally deduced from experiments made on working models, which are the best means of obtaining the outlines in mechanical enquiries; but in every case it is necessary to distinguish the circumstances in which a model differs from a machine at large, otherwise a model is more apt to lead from truth than towards it; and we must not, without great caution, transfer the results of such experiments to large works. But we may safely transfer the laws of variation, which result from a variation of circumstances, although we must not adopt the absolute quantities of the variations themselves. Mr. Smeaton was fully aware of the limitations to which conclusions drawn from experiments on models are subject, and has made the applications with his usual sagacity. The best structure of machines cannot be fully ascertained but by making trials with them, when made of their proper size.

Mr. Smeaton's Principles for Undershot Wheels.—In comparing the effect produced by water-wheels with the powers producing them; or, in other words, to know what part of the original power is necessarily lost in the application, we must previously know how much of the power is spent in overcoming the friction of the machinery, and the resistance of the air; also, what is the real velocity of the water at the instant it strikes the wheel; and the real quantity of water expended in a given time.

The velocity Mr. Smeaton measured in a most satisfactory manner in every experiment, by applying a cord and weight to the axle of the wheel, not to wind up the weight by the motion

motion of the wheel, but that the weight by descending should turn the wheel. He applied so much weight as would make the wheel turn, and make its floats move with the velocity which he desired or expected the effluent water to have; and this weight he adjusted until he found, by repeated trials, that the wheel moved just at the same rate, whether the water was suffered to flow and strike its floats, or whether the water was stopped, which proved that the floats of the wheel moved with precisely the same velocity as the effluent water; then by measuring the circumference of the wheel, and counting the number of turns it made in a minute, he obtained the measure of the velocity.

From the velocity of the water at the instant that it strikes the wheel, the height of head productive of such velocity can be deduced from acknowledged and experimented principles of hydrostatics; so that by multiplying the quantity or weight of water really expended in a given time by the height of a head so obtained, which must be considered as the effective height from which that weight of water had descended in that given time, we shall have a product equal to the original power of the water, and clear of all uncertainty that would arise from the friction of the water in passing small apertures, and from all doubts arising from the different measure of spouting waters, assigned by different authors.

On the other hand, the sum of the weights raised by the action of this water, and of the weight required to overcome the friction and resistance of the machine, multiplied by the height to which the weight can be raised in the time given, the product will be equal to the effect of that power; and the proportion of the two products will be the proportion of the power to the effect: so that by loading the wheel with different weights successively, we shall be able to determine at what particular load and velocity of the wheel the effect is a maximum.

From experiments conducted in this manner, Mr. Smeaton settled the following maxims:

Maxim 1. That the virtual or effective head of water, and consequently its effluent velocity being the same, the mechanical effect produced by a wheel actuated by this water will be nearly in proportion to the quantity of water expended.

Note. The virtual or effective head of any water which is moving with a certain velocity, is that height from which a heavy body must fall in order to acquire the same velocity.

The height of the virtual head, therefore, may be easily determined from the velocity of the water; for the heights are as the square of the velocities; and the velocities, consequently, as the square roots of the heights. Mr. Smeaton observed the velocity of the effluent water in all his experiments, and thence calculated the virtual head; he states that the virtual head bears no proportion to the real head or depth of water; but that when either the aperture is greater, or when the velocity of the water issuing therefrom less, they approach nearer to a coincidence; and consequently, in the large openings of mills and sluices, where great quantities of water are discharged from moderate heads, the actual head of water, and the virtual head, as determined by theory from the velocity, will nearly agree.

For example of the application of his first maxim. Suppose a mill driven by a fall of water, whose virtual head is 5 feet, and which discharged 550 cubic feet of water per minute; and that it is capable of grinding four bushels of wheat in an hour. Now another mill, having the same virtual head, but which discharges 1100 cubic feet of water per minute, will grind eight bushels of corn in an hour.

Maxim 2. That the expence of water being the same, the effect produced by an undershot wheel will be nearly in pro-

portion to the height of the virtual or effective head. This is proved in the preceding example.

Maxim 3. That the quantity of water expended being the same, the effect will be nearly as the square of the velocity of the water; that is, if a mill driven by a certain quantity of water, moving with the velocity of 18 feet per second, is capable of grinding 4 bushels of corn in an hour, another mill, driven by the same quantity of water, but moving with the velocity of $22\frac{1}{2}$ feet per second, will grind nearly 7 bushels of corn in an hour; because the square of 18 is 324, and the square of $22\frac{1}{2}$ is $506\frac{1}{4}$. Now say, as 324 is to 4 bushels, so is $500\frac{1}{4}$ to $6\frac{1}{2}$ bushels; that is, as 4 to $6\frac{1}{2}$.

Maxim 4. The aperture through which the water issues being the same, the effect will be nearly as the cube of the velocity of the water issuing; that is, if a mill driven by water rushing through a certain aperture with the velocity of 18 feet per second will grind 4 bushels of corn in an hour, another mill, driven by water moving through the same aperture, but with the velocity of $22\frac{1}{2}$ feet per second, will grind 51 bushels; for the cube of 18 is 5832, and the cube of $22\frac{1}{2}$ is 11390 $\frac{3}{4}$; then, as 5832 is to 4, so is 11390 $\frac{3}{4}$ to $7\frac{3}{4}$.

Maxim 5. The proportions between the power of the water expended, and the effect produced by the wheel, was 3 to 1. Upon comparing several experiments, Mr. Smeaton fixed the proportions between them for large works; that is, if the weight of the water which is expended in any given time be multiplied by the height of the fall, and if the weight raised be also multiplied by the height through which it is raised, the first of these two products will be three times that of the second.

Maxim 6. The best general proportions of velocities between the water and the floats of the wheels will be that of 5 to 2; for instance, if the water when it strikes the wheel moves with a velocity of eighteen feet per second, the wheel must be so loaded that its float-boards will move with a velocity of 7.2 feet per second, and the wheel will then derive the greatest power from the water, because as 5 to 18, so is 2 to 7.2.

Maxim 7. There is no certain ratio between the load that the wheel will carry when producing its maximum of effect, and the load that will totally stop it; but it approaches nearest to the ratio of 4 to 3, whenever the power exerted by the wheel is greatest, whether it arises from an increase of the velocity, or from an increased quantity of water; and this proportion seems to be the most applicable to large works. But when we know the effect a wheel ought to produce, and the velocity it ought to move with whilst producing that effect, the exact knowledge of the greatest load it will bear is of very little consequence in practice.

Maxim 8. The load that the wheel ought to have, in order to work to the most advantage, can be always assigned thus: ascertain the power of the whole body of water, by multiplying the weight of the water expended in a minute by the height of the fall, take one-third of the product, and it gives the effect of power which the wheel ought to produce: to find the load, we must divide this product by the velocity which the wheel should have, and that, as we have before settled, should be two-fifths of the velocity with which the water moves when it strikes the wheel.

The wheel must not be placed in an open river to be actuated by the natural current, in which case, after it has communicated its impulse to the float, it has room on all sides to escape: this is the supposititious case on which most mathematicians have proceeded; but in all these experi-

ments, the wheel is placed in a conduit or race, to which the float-boards are exactly adapted, and the water cannot otherwise escape than by moving along with the wheel. It is observable in a wheel working in this manner, that as soon as the water meets the float, it receives a sudden check, and rises up against the float, like a wave against a fixed object, inasmuch that when the sheet of water is not a quarter of an inch thick before it meets the float, this sheet will act upon the whole surface of a float, whose height is three inches; and consequently, where the float is no higher than the thickness of the sheet of water, as theory also supposes, a great part of the force would have been lost by the water dashing over the float.

The wheel which Mr. Smeaton used had originally twenty-four floats, and was afterwards reduced to twelve, which caused a diminution in the effect, on account of a greater quantity of water escaping between the floats and the floor of the channel in which it moved; but a circular sweep being adapted thereto, of such a length, that one float entered the curve before the preceding one quitted it, the effect came so near to the former as not to give hopes of advancing it, by increasing the number of floats beyond twenty-four in this particular wheel.

Mr. Smeaton observes that, in many of the experiments, the results were by different ratios than those which his maxims supposed; but as the deviations were never very considerable, the greatest being about one-eighth of the quantities in question, and as it is not practicable to make experiments of so compound a nature with absolute precision, he supposes, that the lesser powers are attended with some friction or work under some disadvantages, which have not been duly accounted for; and, therefore, he concludes that these maxims will hold very nearly, when applied to works in large.

Application of these Principles to Practice.—The first thing to be done in a situation where an undershot wheel is intended to be fixed, is to consider whether the water can run off clear from the wheel, so as to have no back water to impede its motion; and whether the fall which can be obtained by constructing a proper dam to pen up the water and sluice for it to pass through, will cause it to strike the float-boards of the wheel with a sufficient velocity to impel them forcibly forwards; and also, whether the quantity of the supply will be sufficient to keep a wheel at work for a certain number of hours each day.

When we have ascertained the height of the fall of water, that is, the height of the surface above the centre of the opening of the sluice, we must find what will be the continual velocity of the water issuing out from such opening.

In some cases, we have the velocity of the water given when it issues from the opening of the sluice, and we then require to know what height of column will produce that velocity. These two things we may find by a single rule, and an easy arithmetical operation, which is as follows:

1st. The perpendicular height of the fall of water being given in feet and decimals of feet, the velocity that the water will acquire *per second*, expressed in feet and decimals, may be found by the following rule:

Multiply the constant number 64.2882 by the given height, and the square root of the product is the velocity required.

Example 1.—If the height is two feet, the velocity will be found 11.34 feet *per second*.

Example 2.—If the height is 16,0913 feet, the velocity will be 32,1826 feet *per second*.

Example 3.—If the height is fifty feet, the velocity will be 56,68 feet *per second*.

Note. The velocities thus obtained will be only the theoretic velocity, that is, the velocity any body would acquire by falling through such height *in vacuo*, the velocity in reality will be less, generally six or seven-tenths.

The uniform velocity of a fluid being given, expressed in feet and decimals of feet *per second*, the height of the column or fall to produce such a velocity may be found by the following rule:

Multiply the given velocity into itself, and divide the product by 64,2882; the quotient will be the height required, expressed in feet and decimals.

Example 1.—If the velocity given is three feet *per second*, the height will be 0.139 of a foot.

Example 2.—If the velocity given is 32,1826 feet *per second*, the height will be found 16,0913 feet.

Example 3.—Let the velocity be 100 feet *per second*, the height will be 155,649 feet.

The knowledge of the foregoing particulars is absolutely necessary for constructing an undershot water-wheel; but the most advantageous method of setting it to work, and to find out the utmost it could perform, would be very difficult, if we were not furnished with the maximum which Mr. Smeaton settled, by shewing, that an undershot water-wheel will act to the greatest advantage, when the velocity of its float-boards is equal to two-fifths or four-tenth parts of that of the water which gives it motion.

To illustrate this, let us consider a wheel equally balanced on all sides, and turning freely round upon its pivots, its circumference would soon move as fast as the current it was placed in. Suppose the water to move at the rate of three feet in a second, the circumference of the wheel would pass through three feet in a second. In this case, the wheel performs no work, and the effect produced is nothing.

Now in attempting to apply the power of this wheel to turn any kind of machinery, suppose the work to be so proportioned, that the resistance would cause the wheel to stand still and stop the water, or make it run over the floats, in consequence of its not having sufficient force to carry the float-boards along with it. In this case also, there being no motion, there could be no mechanical effect produced; but if the resistance be diminished by degrees, the wheel would begin to partake of the motion of the current of water, and being loaded, would produce a mechanical effect proportioned to the load and velocity. The wheel would increase in its velocity in proportion as the resistance was diminished, and the mechanical effect would increase also until a certain point when the wheel moved so fast, that the water would not strike the float-boards quick enough to produce the greatest effect: this is found to be as before mentioned, when the floats move four-tenths as fast as the water, because then six-tenths of the water is employed in driving the wheel with a force proportional to the square of its velocity.

If we multiply the surface or area of the opening by the height of the column, we shall ascertain the body or column of water which should press against that float-board, which is immediately under the wheel, supposing it has no motion; but it will be found, that a small proportion of the weight of the original column hung on the opposite side of the wheel, would arrest its motion entirely; but when we would have it to move with a proper velocity, that is, two-fifths of that velocity with which the water moves, $\frac{1}{16} \frac{3}{16} \frac{9}{16}$ of the weight of the original column, is the weight which the wheel would raise with four-tenths of the velocity that the water moves with, and the power which the wheel would exert on the machinery to grind corn, lift hammers, raise water,

WATER.

water, &c. is $\frac{1}{1000}$ of the weight of the water multiplied by $\frac{1}{10}$ of its velocity.

Thus it appears that an undershot water-wheel, constructed after the foregoing manner, would only raise one-third part of the water expended to the same height, as the original head or level. This is the utmost that can be expected, though often less is done; because here we suppose every part exactly performed, and the water applied to the wheel in the best manner; therefore, as we cannot come up to the maximum, we must come as near it as we can by losing the least possible of the power's impulse.

It is no advantage to have a very great number of float-boards round the wheel, because when they are struck by the water, as applied in the best manner possible, the sum of the impulses exerted on the different floats, will but be equal to the impulse made against one float-board struck by all the water issuing from the sluice at right angles to its surface. But as this float-board must move forward, there must be a succession of float-boards to receive the impulse of the water, and since they cannot receive it at right angles, there will be some loss of impulse in that succession. Besides when the first float-board is so far past the perpendicular, as to have the action of the water intercepted by the succeeding one, it is checked by the back water through which it must pass in rising out of the water, and thereby be so far retarded as to take from the full effect of the impulse on the following float. Indeed if all the water could run off immediately after having performed its office, this would not happen; but it can seldom be effected in undershot-mills, especially those built upon rivers. All the remedy in such case is, (when the diameter of the wheel is settled) to fix just such a number of floats upon it, that each one, after it has received the full impulse of the water, may come out of the water as soon as possible, that another succeeding float may be brought to receive the impulse, otherwise the wheel would remain a moment without any impulse.

In the article *MILL* we have given a table for the dimensions and proportions for undershot wheels, which was calculated by Mr. Ferguson. Dr. Brewster, in his new edition of Mr. Ferguson's works, has given an improved table, which is calculated upon the following principles.

It is evident that the water-wheel must always move with less velocity than the water, even when there is no work to be performed; for a part of the impelling power is necessarily spent in overcoming the *inertia* of the wheel itself; and if the wheel has little or no velocity, it is equally manifest that it will produce a very small effect.

There is consequently a certain proportion between the velocity of the water and the wheel, when the effect is a maximum. Mr. Smeaton has shewn the greatest effect is produced when the velocity of the wheel is between one-third and one-half, but the maximum is much nearer to one-half than one-third. He observes also that one-half would be the true maximum, if nothing were lost by the resistance of the air, the scattering of the water carried up by the wheel, and thrown off by the centrifugal force, and the leakages of the water between the floats and the water-course, all which tend to produce a greater diminution of the effect at that velocity, which would be the maximum if these losses did not take place, than they do when the motion is a little slower. The great hydraulic machine at Marly, the wheels of which are undershot, was found to produce a maximum effect when the velocity of the wheel was two-fifths that of the current. Hence Dr. Brewster concludes that in theory the velocity of the wheel is one-half that of the current, and that

in practice it is never more than three-eighths of the stream's velocity, when the effect is a maximum.

Dr. Brewster's Table of undershot Water-Wheels, in which the velocity of the wheel is three-sevenths of the velocity of the water, and the effects of friction on the velocity of the stream are reduced to computation. The wheel is supposed to be fifteen feet diameter.

Height of the Fall of Water.	Velocity of the Water per Second, Friction being considered.	Velocity of the Wheel per Second being three-sevenths that of the Water.	Revolutions of the Wheel per Minute, its Diameter being fifteen Feet.
Feet.	Feet and Decimals.	Feet and Decimals.	Revolutions and Decimals.
1	7.62	3.27	4.16
2	10.77	4.62	5.88
3	13.20	5.66	7.20
4	15.24	6.53	8.32
5	17.04	7.30	9.28
6	18.67	8.00	10.19
7	20.15	8.64	10.99
8	21.56	9.24	11.76
9	22.86	9.80	12.47
10	24.10	10.33	13.15
11	25.27	10.83	13.79
12	26.40	11.31	14.40
13	27.47	11.77	14.99
14	28.51	12.22	15.56
15	29.52	12.65	16.13
16	30.48	13.06	16.63
17	31.42	13.46	17.14
18	32.33	13.86	17.65
19	33.22	14.24	18.13
20	34.17	14.64	18.64

Another Manner of applying Water to an undershot Wheel.—This was proposed by M. Fabre as the result of much mathematical investigation, and has been so frequently recommended by authors of eminence, that we shall give a short description without entering into all his rules for the proportions. The principal difference in this wheel from that in common use is, that the water is made to run down a rapid slope or inclined plane, in order to strike the floats of the wheel, instead of issuing from an aperture or sluice situated beneath the surface of the water in the reservoir. A mill is usually situated at a distance from the river, with a canal or water-course to conduct the water to the mill; as it is of the highest importance to have the height of the fall as great as possible, the bottom of the canal or water-course, which conducts the water from the river to the mill, should have a very small declivity; for the height of the water-fall at the mill will diminish in proportion as the declivity of the canal is increased: it will be sufficient to make it slope about one inch in 200 yards, taking care to make the declivity about half an inch in the first 48 yards, in order that the water may have a velocity sufficient to prevent it from flowing back into the river.

When the water is thus brought to the channel in which the wheel is placed, the water is recommended to be conducted down a slope or inclined plane, making an angle of $64\frac{1}{2}$ degrees with the horizon; that is, in a perpendicular of ten feet, the slope should deviate from it $4\frac{3}{4}$ feet: at the bottom of this slope the water is to be again conducted horizontally, and then to strike the float-boards of the wheel.

wheel. To render the fall of the water easy, the slope is to be rounded off by a convexity at top and a concavity at bottom, to lead the water from the horizontal to the slope, and again from the slope without abruptness. It is supposed that the water, in running down this inclined plane, will acquire the same velocity as if it had fallen perpendicularly through a height equal to the perpendicular height of the slope.

The distance through which the water runs horizontally, from the foot of the slope before it acts upon the wheel, should not be less than two or three feet, in order that the different portions of the fluid may have obtained an horizontal direction; but if this horizontal distance be much larger, the velocity of the stream would be diminished by its friction on the bottom and sides of the water-course. That less water may escape between float-boards and the bottom of the course, it should be formed into the arch of a circle concentric with the wheel, which sweep should be prolonged, so as to support the water as long as it can act upon the float-boards; beyond this sweep should be a step or fall of not much less than nine inches with a slope of about 45 degrees, that the water having spent the greater part of its force in impelling the float-boards, may not accumulate below the wheel and retard its motion. After this step the course of discharge, or tail water-course to run off the water from the wheel, should be floored with wood or masonry about 16 yards long, having an inch of declivity in every two yards.

The canal which conducts the water from the course of discharge to join the river again, should slope about four inches in the first 200 yards, and three inches in the second 200 yards, and so decreasing gradually till it terminates in the river. But if the river to which the water is conveyed, should be subject to be swollen by the rains, so as to force the water back upon the wheel, the canal must have a greater declivity, in order to prevent this from taking place. Hence it will be evident, that very accurate levelling is necessary for the proper formation of the mill-course. The tail water-course ought always to have a very considerable breadth, which should be greater than that of the wheel-race, or part in which the wheel acts, that the water having room to spread may have less depth. The section of the fluid at the point where it strikes the wheel should be rectangular, the breadth of the stream having a determinate relation to its depth. If there is a great stream of water, the breadth should be triple the depth; if there is a moderate quantity, the breadth should be double the depth; and if there is very little water, the breadth and the depth should be equal. The depth of the water here alluded to is its natural depth, or that which it would have, if it did not meet the float-boards. The effective depth is generally two and a half times the natural depth, and is occasioned by the impulse of the water on the float-boards, which forces it to swell, and increases its action upon the wheel.

As it is of great consequence that none of the water should escape, either below the float-boards or at their sides, without contributing to turn the wheel, the breadth of the float-boards should be wider than the sheet of water which strikes them. The diameter of the water-wheel should be as great as possible, unless some particular circumstances in the construction prevent it; but ought never to be less than seven times the natural depth of the stream or thickness of the sheet of water, where it meets the float-boards. The wheel will move irregularly, sometimes quick and sometimes slow, according to the position of the floats with respect to the stream; unless the number of float-boards is considerable, the wheel must have so many floats, that

two floats will at least be always in the circular sweep at the bottom of the wheel; but in order to remove any inequality of motion in the wheel, and prevent the water from escaping beneath the tips of the float-boards, it should have as many float-boards as possible, without loading it, or weakening the rim on which they are placed. The float-boards should not be perpendicular to the rim, or, in other words, a continuation of the radius, but should be inclined to the radius; the water will thus heap upon the float-boards, and act not only by its impulse, but also by its weight. When the velocity of the stream is eleven feet *per* second, or above this, the inclination should never be less than thirty degrees; or when this velocity is less, the inclination should diminish in proportion; so that when it is four feet, or under, the inclination should be nothing, that is, the float-boards should point to the centre of the wheel.

It is a strong practical objection to this manner of applying the water to the wheel, that when the water of the river sinks in dry weather from a deficiency of water, it would not run over the top of the fall, and the mill could not work at all even if it sunk only ten or twelve inches: in like manner, when the water rises in floods, the water at the top of the fall would become so deep, as to require some shuttle to prevent it from inundating the wheels, at the same time that the stagnant water in the mill race would prevent the wheel from working. Almost all rivers are subject to floods, and often they rise and fall, three, four, six, and eight feet above their ordinary level in fair weather; now the water mostly rises at the tail or discharge of the water as much as the head, and the wheel-race will therefore be full of stagnant water, which is called tail-water, and obstructs the motion of the wheel.

In a ground-shot wheel, where the water issues from a shuttle on a level with the bottom of the wheel-race, it can always work in dry seasons, as long as the river contains any water, although the power diminishes almost to nothing, when the water sinks low, and will not rush out with force from the shuttle. In floods of water, this wheel has a greater advantage, because the depth of head which urges the flowing water is increased when the water is high, and this makes it drive the tail-water forcibly out of the wheel-race, and enable the wheel to work, when a wheel with an inclined fall would infallibly be stopped.

Breast-wheels and overshot-wheels, properly constructed, have still greater advantages, in clearing themselves from tail-water, and this is a very important object.

Floating-Mill with undershot Wheels.—A large floating water-mill, to be worked by the tides or currents, was stationed some years ago in the river Thames, between London and Blackfriars bridge, by permission of the Board of Navigation. Such permission having been granted with the view of reducing, if possible, the price of flour in the metropolis, and contributing to a constant supply of that necessary article of subsistence. The simplicity of this invention renders a long description superfluous, as it consists in merely applying the force of two large undershot water-wheels on each side of a barge, or any other vessel calculated to contain the interior part of the machinery; the float-boards are disposed in a proper manner to be acted on by the tide or current, so as to give the wheels a rotatory motion, and by connecting them with proper machinery, to answer the purposes for which the mill is intended.

Any ship, brig, sloop, or other vessel, may be used for this purpose, provided it is of sufficient size to accommodate the works to be erected, yet in point of expence it will be better to employ such as are rendered unfit for sea-service.

When it is intended that the ship or mill should be stationary, it must be anchored, moored, or otherwise made fast, so as to swing with the tide when necessary; but the mill may be worked while the vessel in which it is erected is sailing, when wind and other circumstances permit.

The number and size of the water-wheels to be used may be varied, according to the size of the ship or vessel, or to the strength of the tide or current, and the power required; and the wheels may be constructed as in common undershot mills, or with folding-floats, for the more readily freeing them from the water: two wheels are to be placed vertically, on an horizontal axis, of such length, that, the axis being placed across the ship or vessel, one wheel may run on each side of it on the same axis.

A mill constructed in the manner above described may be moved by the strength of from two to six large water-wheels, or such other number as the ship or vessel will accommodate. These water-wheels may dip into the water from three to four, or more feet deep; they should be so connected together as to be easily engaged with and disengaged from each other, so that during the weak part of the tide they may all be made to act on one pair of mill-stones, if necessary; and as the strength of the tide increases, more stones or other machinery may be put in motion, so as at all times to do business in proportion thereto.

In a mill of this kind the water-wheels do not admit of having water-courses, or any equivalent contrivances, to conduct the water to the wheels, as in other undershot wheels; but the float-boards must be large enough to receive the power required from merely dipping into the current of the tide-water.

The vessel of the mill in the Thames is the hull of an old ship of two or three hundred tons burthen, which being moored in the river by chains, so that it can swing round when the tide changes, the wheels will always turn the same way round; one water-wheel is fixed on each side of the vessel, a long iron axis being common to both; the extreme ends of the axis are supported in a frame-work of timber, and another very strong frame of timber is fixed outside of the wheels at the level of the water, which floats in the water, and is only attached to the mill by chains; this is to protect the wheels from injury, by vessels which pass and repass. Each water-wheel is 18 feet diameter, and 14 feet broad; the float-boards are each 3 feet deep, and are about sixteen in number, affixed on the circumference of cart iron-wheels, or circles, which are 12 feet diameter, there are three of these circles for each wheel; hence we find each float-board exposes a surface of 42 square feet to the action of the current, and if we suppose each wheel to have two floats in action at the same time, the power of the mill will be derived from 168 square feet acted upon by the water, which seldom exceeds a velocity of four miles *per* hour, or 352 feet *per* minute.

The iron axis of the water-wheels is a hollow tube of nine inches diameter outside, and five inches within, made in four lengths of 12 feet each, properly joined together, and extending across the vessel from one wheel to the other. On the middle of this axis a large wheel of 11 feet diameter is fixed, and surrounded by a brake or gripe like that used in a wind-mill, the use of which is to stop the mill when it requires repairing. Near to this brake-wheel is a large bevelled cog-wheel 13 feet diameter, with 89 cogs, which gives motion to a bevelled pinion two feet eight inches diameter, with eighteen cogs fixed on the top of a vertical axis. On this axis is also a large horizontal spur-wheel 12 feet diameter, with 201 cogs, which gives motion to pinions of one foot diameter, and 17 cogs fixed on the spindles of the mill-

stones. There are four pair of mill-stones, two pair of 4½ feet and two pair of 3½ feet diameter, and the mill also works a dressing-machine for the flour. The mill-stones make 57½ revolutions for one revolution of the water-wheels, which move very slow, scarcely two turns *per* minute, in the most favourable periods of the tide. The circumference of each taken through the middle of the float-boards is 47 feet; hence the float-boards move about 94 feet *per* minute, when the mill-stones make their proper number of revolutions to grind with the greatest effect.

It was found that on a flood-tide, this mill would drive two pair of 3½ feet mill-stones, and a flour dressing-machine, but on the ebb-tide only one pair of 4-foot stones and the machine; thus it is only the performance of a small mill, although the wheels are of large dimensions, and it would require enormous wheels to make an effective floating mill in the river Thames.

This machine is now removed from the river, because it was found to do so much injury to the vessels which continually ran against its floating frame, and the repairs of the damages frequently done to the mill by ice and the craft took away all the advantages of the mill.

Undershot Wheels with oblique Floats.—Attempts have been made to construct water-wheels for tide-rivers which receive the impulse obliquely, like the sails of a common wind-mill. This would in many situations be a great advantage. A very slow but deep river could in this manner be made to drive mills; and although much power would be lost by the obliquity of the impulse, the remainder might be very great. Dr. Robinfon speaks of a wheel of this kind which was very powerful; it was a long cylindrical frame, having a plate standing out from it about a foot broad, and surrounding it with a very oblique spiral like a cork-screw. This was immerfed about one-fourth of its diameter (which was nearly 12 feet), having its axis in the direction of the stream. By the work which it was performing, it seemed more powerful than a common wheel which occupied the same breadth of the river. Its length was not less than 20 feet; had it been twice as much it would have been nearly redoubled in its power without occupying more of the water-way. It is probable such a spiral continued quite to the axis, and moving in a hollow canal wholly filled by the stream, might be a very advantageous way of employing a deep and slow current.

In the Transactions of the Society of Arts, vol. xix. a water-wheel is described, in which the float-boards are placed obliquely to the axis of the water-wheel at about an angle of 40 degrees, being fixed to the rim in pairs, which are inclined equally to the axis of the wheel, but in opposite directions to each other; so that the two float-boards of each pair point towards each other in an angle of about 80 degrees, and if the pair of floats were continued they would meet in the middle of the breadth of the wheel. The water is made to strike the floats within this angle, and in consequence all the water which is emitted by the sluice and strikes upon the oblique floats will be reflected from the sides or ends of the two pair of float-boards towards the vertex of the angle, which they make; but the pair of floats do not touch each other, so that the vertex of the angle is open; but to prevent the water passing freely through the open angle, one of the float-boards is made to extend far beyond the vertex, or point, where they would intersect, and the other is made to fall short of it, nevertheless the water would certainly pass through the opening. It is stated, that the motion of the ordinary wheel with parallel floats is greatly retarded by the resistance which they experience in rising up or quitting the tail-water of the stream, from the pressure

pressure of the atmosphere on their upper surface before the air gets admission beneath the floats; but in Befant's wheel this resistance is greatly diminished, as the floats emerge from the stream in an oblique direction. The water-wheel is constructed in the form of a hollow drum, so as to resist the admission of the water. Although this wheel is much heavier than those of the common construction, yet it revolves more easily upon its axis, as the stream has a tendency to make it float. We cannot recommend this wheel, but on the contrary think it one of the worst forms, as it tends to increase that loss which arises in all undershot-wheels from the change of figure which the water must undergo when it strikes the float, and we should not have mentioned it, but that it has been so frequently copied and recommended by different authors.

Horizontal Water-wheels actuated by the Impulse of Water.

—These have been considerably in use on the continent, and deserve our notice from the simplicity of their construction. The wheel is constructed in the same manner as an undershot-wheel, having float-boards fixed round its circumference in the form of radii; it is mounted on a vertical axis, the upper end of which is fixed to the spindle of the mill-stone, if the mill is intended to grind corn; but in some cases, it is better to fix a cog-wheel on the upper part of the vertical axis with teeth round its edge, to give motion to trundles or pinions on the spindles of the mill-stones, because the floats of the wheel must always be made to move with a given proportion of the velocity of the water. The wheel-race or water-course may be made nearly the same as for an undershot-wheel, if we suppose it laid down in an horizontal position; that is, a trough or channel of masonry is constructed in which the wheel works, and the float-boards of the wheel are exactly fitted to it: at one end of this channel is the aperture or sluice through which the stream of water issues, and strikes the floats of the wheel so as to turn it round, and the water passes forwards and escapes at the other end of the channel. When the water is delivered upon the wheel in an horizontal direction, or perpendicular to its axis, the float-boards should be inclined about twenty-five degrees to the plane of the wheel, and the same number of degrees to the radius, so that the lowest and outermost sides of the float-boards may be farthest up the stream and be met by the water first.

In many cases, the water-course is made inclined to the plane of the wheel in such a degree, that the water may strike the float-boards perpendicular to their surfaces.

In the southern provinces of France, where horizontal water-wheels are generally employed, the float-boards are made of a curvilinear form so as to be concave towards the stream; they are generally segments of spheres, or hollow wooden bowls or ladles fixed on the rim of the wheel: the water, in this case, is conducted through a pipe, and projected in a jet on a direction a little inclined to the horizon. When the height of water is very considerable, this is, perhaps, the best form for the floats, or ladles, as they are called.

The chevalier de Borda observes, that in theory a double effect is produced when the float-boards are concave, but that the effect is diminished in practice, from the difficulty of making the fluid enter, and leave the curve in a proper direction. Notwithstanding this difficulty, however, and other defects which might be pointed out, horizontal wheels with concave float-boards are always superior to those in which the float-boards have plane surfaces.

Mr. Smeaton constructed a small corn-mill with a horizontal water-wheel, of which the following are the principal dimensions. Fall of water $52\frac{1}{2}$ feet; diameter, or

bore of the nose-pipe through which the water issued in a jet to strike upon the wheel, $1\frac{1}{2}$ inch; diameter of the water-wheel 10 feet to the centre of the floats or ladles, which were twelve in number; they were made of a concave form, nearly segments of spheres, and about 14 inches in diameter; and fixed round the circumference of the wheel, so that the planes of the circular rims, or edges of the hollow ladles, were not perpendicular to the plane of the wheel, but inclined thereto in such a degree, that the jet of water issuing from the nose-pipe at an angle of 22 degrees from the horizontal line, would strike the floats in the centre and perpendicular to the circular edge of the hollow; the internal surface of the floats being really spherical, the water would always strike perpendicularly into the concavity of the bowl. The water-wheel axis rose up perpendicularly into the mill-house, and on the top a wheel of 4 feet 8 inches in diameter, and 44 cogs, was fixed for giving motion to the pinions on the axis of the mill-stones. The largest pinion of 17 cogs was fixed on the axis of a pair of stones 4 feet 6 inches in diameter, and the smaller pinion of 13 cogs on the axis of a stone 3 feet 6 inches in diameter. It was not intended to turn both these pairs of stones at the same time, but it was necessary to have two pairs for different uses.

When this mill moved with a proper velocity to grind to the greatest advantage, if the 4 feet 6 inches stones were used, the water-wheel made 25 revolutions *per* minute, and the stones therefore made 65 revolutions *per* minute, and the float-boards moved with a velocity of 784 feet *per* minute; but when turning the smaller mill-stones of 3 feet 6 inches diameter, the water-wheel went best when it made 26 revolutions, and therefore turned the mill-stone 88 turns *per* minute; and the velocity of the floats was 816 feet *per* minute.

Mr. Smeaton calculated the velocity of the water issuing from the pipe at 3403 feet *per* minute, which is the velocity due to a 50 feet fall, because he allowed the $2\frac{1}{2}$ feet to overcome friction, and the expenditure of the $1\frac{1}{2}$ inch nose-pipe at 30 cubic feet *per* minute allowing for friction. This mill ground one bushel of wheat *per* hour, on the average of a great many experiments, now $30 \times 50 = 1500$ cubic feet, falling one foot *per* minute. It is found by repeated experiments, that 600 cubic feet falling one foot *per* minute on a good water-wheel is an ample allowance for grinding a bushel of wheat, as it may be done by 530; hence this fall of water ought to have ground $2\frac{1}{2}$ bushels *per* hour instead of one. The mill, however, admits of improvement in making the floats of the wheel move quicker.

When the mill-stone of an horizontal mill is fixed on the upper end of the axis of the water-wheel, if the mill-stone be five feet in diameter, it should never make less than sixty turns in a minute, and the wheel must perform the same number of revolutions in the same time; and in order that the effect may be a maximum, or the greatest possible, the velocity of the current must be more than double that of the wheel.

Suppose the mill-stone, for example, to be 5 feet diameter, and the water-wheel 7 feet, it is evident that the mill-stone and wheel must at least revolve 60 times in a minute; and since the circumference of the wheel is 22 feet, the float-boards will move through that space in the 60th part of a minute, that is, at the rate of 22 feet *per* second; which being doubled, makes the velocity of the water 44 feet one second, answering, as appears from the rule, for the velocity of falling water, to a fall of 30 feet. But if the given fall of water be less than 30 feet, we may procure the same velocity to the mill-stone, by diminishing

ing the diameter of the wheel. If the wheel, for instance, is only 6 feet diameter, its circumference will be 18.8 feet, and its floats will move at the rate of 18.8 feet in a second, the double of which is 37.6 feet *per* second, which answers to a head of water 22 feet high. The diameter of the water-wheel, however, should never be less than 6 or 7 feet, because the float-boards change their direction so rapidly, in consequence of their proximity to the centre, that they will not receive the full action of the water, because it acts in a perpendicular direction to the float-board only for a moment. Hence there will be a certain height of the fall, beneath which the simple horizontal wheel cannot be employed; and beyond that, wheel-work must be introduced to obtain the requisite velocity for the mill-stones.

In the provinces of Guienne and Languedoc, in France, another species of horizontal wheel is employed for turning machinery. It consists of an inverted cone, with spiral float-boards of a curvilinear form winding round its surface. The wheel moves on a vertical axis in a pit or well of masonry, to which it is exactly fitted, like a coffee-mill in its box. It is driven chiefly by the impulse of the water, conveyed by a spout or canal in a stream, which strikes the oblique float-boards; and when the water has spent its impulsive force, it descends along the spiral float-boards, and continues to act by its weight till it reaches the bottom, where it is carried off by a canal. The idea of this machine is ingenious. The jet of water, being first applied to the upper or largest part of the cone, strikes the float-boards at the part where they move with the greatest velocity, in consequence of their being on the largest radius; but as the water loses its velocity, in consequence of the motion it has imparted to the wheel, it descends in the cone, and acts upon the floats lower down, where, the radius being less, the floats move more slowly, and are therefore better adapted to receive the action of the water with its diminished velocity.

M. Mannoury Desfont's horizontal Water-Wheel, which he calls Danaide.—This receives the impulse of the water in a different manner from any which we have described, and is described in a report to the Institute of France in 1813. The water-wheel is fixed in a horizontal position upon a vertical axis, and supported upon the pivots thereof, so as to be capable of turning round. It is not in reality a wheel, but a hollow cylinder or drum capable of containing water; it is open at top, and united to the axis in the centre of the circular plane, which forms the bottom. Within this drum, and concentric with it, a solid cylinder is fixed; it is of less dimensions than the drum itself, and occupies such portion of the content of the drum as to reduce the open part which can contain water to a hollow ring or circular trough, open at top, and of a considerable depth, but only a few inches in width. The depth is described as being nearly as great as the diameter of the wheel.

The water coming from an elevated reservoir, is projected in jets from one or more pipes into this annular space which surrounds the rim of the wheel. These pipes descend in an inclined direction, till they are nearly on a level with the surface of the water in the annular space; and the extremities turn horizontally, so as to project the jet horizontally, and in the direction of tangents to the mean circumference of the water contained in the annular space.

Suppose this space which surrounds the wheel is full of water, then the stream issuing from the jet causes the wheel to turn round upon its axis, because it takes hold or acts upon the water in the annular space, and tends to give the water a circulating motion within the annular space; but the

friction, or resistance, which the water would find in such circulation, causes the wheel to turn round with the water, unless the load on the wheel, or resistance to its motion, is too great.

The water which is continually thrown into the wheel escapes from the annular space by passages which proceed from the bottom thereof to the centre of the wheel; and there are openings at the centre, where the water can drop out *below*. To form the passages for this purpose, the solid cylinder which is fixed in the centre of the hollow drum is of less depth than the other, and leaves a space between the bottom of the solid and the bottom of the hollow, which is divided into compartments by diaphragms fixed upon the bottom of the trough, and proceeding like radii from the circumference to a central hole in the bottom of the trough, which is left open to allow the water to escape. The report states, that the velocity with which the water issues from the jets makes the machine move round its axis; and this motion accelerates by degrees, till the velocity of the water in the annular space equals that of the water from the reservoir, so that no sensible shock is perceived of the affluent water upon that which is contained in the machine. The motion of the wheel is regular, because the action is continual; but in the case of other water-wheels, where the water strikes against float-boards, such boards must necessarily be of a determinate number, and the motion must be given to the wheel by a succession of impulses, as the floats arrive before the stream. We might indeed suppose a wheel with an infinite number of floats, but it would then amount to a plain cylindrical or flat surface, upon which the water would not take sufficient hold to produce any sensible effort to turn it round.

Now in M. Desfont's wheel, in place of float-boards, the rim of the wheel is clothed with water, which is capable of being acted upon by the water issuing from the jets. This action tends to put the water in the annular space in motion, and to carry the wheel along with it, by the adhesion it must naturally have to the sides of the channel which contains it. The velocity of the wheel will be in proportion to the resistance that the load makes to its motion.

The circular motion of the wheel communicates a centrifugal force to the water contained in the annular cavity of its rim, which causes it to press against the outermost side of the channel. This centrifugal force acts equally upon the water contained in the compartments at the bottom of the said rim; but its action diminishes as the water approaches the centre.

The whole mass of water is then animated by two opposite forces, *viz.* gravity and the centrifugal force. The first tends to make the water run out at the hole in the bottom of the wheel at the centre, and the second to drive the water from that hole.

To these two actions are joined a third, *viz.* friction or resistance, which acts an important and singular part; and in this machine the friction of the water produces its powers of action, while in most other machines it always diminishes their powers. The effect in this machine would be nothing, were it not for the resistance which the water finds opposed to its free circulation in the annular space round the rim of the wheel.

By the combination of these three forces there ought to result a more or less rapid flow of water from the hole in the centre at the bottom of the wheel; and the slower this water issues, the greater will be the effective power of the machine for producing the useful effect for which it is destined.

The moving power in this machine, like all others, is the weight of the water which runs into the wheel, multiplied by

by the elevation the reservoir has above the bottom of the wheel, or orifice from which it issues in quitting the same; but the useful mechanical effect is stated to be equal to that product, diminished by half the force which the water retains, when it flows out at the orifice below, and quits the machine.

In order to ascertain, by direct experiment, the magnitude of this effect, Messrs. Prony and Carnot fixed a cord to the axis of the machine, which passing over a pulley, raised a weight by the motion of the machine. By this means the effect was found to be $\frac{7}{10}$ ths of the power, and often approached $\frac{7}{10}$ ths, without reckoning the friction of the pulleys, which has nothing to do with the effect.

We cannot help suspecting some mistake in these experiments, or in the statement of them, but think the machine deserves a trial; and if it should produce near the result above stated, it would be a most valuable addition to our means of employing falls of water; and its simplicity would be a great recommendation, particularly for corn-mills, because the perpendicular axis is immediately adapted for that purpose, without any wheel-work.

Horizontal Mill with oblique Vanes.—In Belidor's Architecture Hydraulique he describes a different form of horizontal mill. The wheel is a circular rim, and the radii or arms are all oblique vanes or floats, precisely the same as the common smoke-jack. This wheel is placed horizontally in a well, to which it is exactly fitted, but the rim of the wheel does not touch the circular wall of the well. The axis of the wheel ascends upwards into the mill-house, and the spindle of the mill-stone is fixed into it. A horizontal arch-way is conducted to the well sideways, and above the part where the wheel is situated. This arch conveys the water into the well over the wheel; and beneath the wheel there is a similar horizontal arch to carry away the water, after it has passed through the wheel, that is, in the spaces between its vanes or floats. The weight of the water presses upon them in a perpendicular direction, and the planes of these floats being all inclined to the horizon, the action of the pressure tends to turn the wheel round on its axis, by the same action as the smoke upon the vanes of a jack, or like a wind-mill.

The water is supplied in such a body through the upper arch, that the well is always kept full, with a considerable depth of water pressing upon the wheel; whilst the lower arch carries away the water so freely, that it runs away from beneath the wheel as fast as it can pass through the vanes of the same.

The mill described by Belidor was at Toulouse, and contained a number of such wheels in a row, each giving motion to one pair of stones.

Horizontal Machines moved by the Reaction of Water.—The reaction of water, issuing horizontally through a spout or orifice, may be employed to communicate motion to machinery; and though this principle has not yet been adopted in practice, it appears from theory, and from some detached experiments on a small scale, that a given quantity of water, falling through a given height, will produce greater effects by its reaction than by its impulse. If we suppose a vertical pipe of any given height, open at both ends, and that water is poured into it at the top, the water will issue at the bottom of the pipe with a velocity proportioned in a certain manner to its altitude, because every particle of water which issues is pressed upon and impelled by the weight of all the particles which are above it. Now, suppose the pipe bent or curved at the bottom, so that it will turn the stream of water into a horizontal position; in this case, the pressure and force, of which we have spoken, will be deflected from the vertical direction to the horizontal. Now

it is clear that the bent part of the pipe, or some part of the interior surface of the tube opposite to the orifice, must sustain all the pressure which is thus deflected or transmitted in another direction; and if the tube is freely suspended, it will retreat before this pressure, and be put in motion. If we suppose the tube to have no resistance to motion, then it would receive all the motion of the water, which would not move at all after it issued from the orifice, but the orifice and tube would move away from the water. This is an impossible case, and in reality the motion of the effluent water will be divided between the pipe or tube and the issuing water, in proportion to the resistance with which each is loaded. Another and perhaps more familiar explanation is, that the water presses against every part of the interior part of the pipe, except against the orifice or aperture, which is open; and in consequence, the unbalanced pressure on the part opposite to the orifice will tend to put the pipe in motion. A sky-rocket mounts in the air from a similar cause.

Dr. Barker's mill by the reaction of water was the first of this kind of machines, and is described by Desaguliers, in 1743. In his Experimental Philosophy, vol. ii. p. 460, he calls it a machine to prove Mr. Parent's proposition experimentally, viz. that an under-shot water-mill does most work, when the water-wheel moves with only a third part of the natural velocity of the water that drives it. He says, that Dr. Barker had this thought, and communicated it to him, saying, that it would be an experimental proof of Mr. Parent's proposition; in consequence of which, Desaguliers made a working model of it, which he shewed to the Royal Society, and the experiments upon it, at their meeting in 1742.

It consists of an upright pipe or trunk, communicating with two horizontal branches, like an inverted T; thus, \perp . This perpendicular pipe is poised upon a pivot at the lower end, and the upper end is connected with the spindle of the mill-stone, or other machine to which it is to communicate motion. The top of the pipe is formed into a funnel, into which a stream of water is conducted, and runs down the pipe: the water escapes through a hole in each of the horizontal arms, which holes are near the ends of the arms, and open in opposite directions, and in such a position that they will direct the stream of water horizontally, and nearly at right angles to the length of the arms.

Suppose water to be poured in at the top of the tube from the spout, it will then run out by the holes at the ends of the arms, with a velocity corresponding with the depth of these holes beneath the surface of the water in the vertical pipe. The consequence of this must be, that the arms must be pressed backwards, for there is no solid surface at the hole on which the lateral pressure of the water can be exerted, while it acts with its full force on the inside of the tube opposite to the hole. This unbalanced pressure, acting upon the opposite sides of both arms, will make the tube and the horizontal arm revolve upon the spindle as an axis.

This will be more easily understood, if we suppose the orifices to be shut up, and consider the pressure upon a circular inch of the arm opposite to the orifice, the orifice being of the same size.

The pressure upon this circular inch will be equal to a cylinder of water, whose base is one inch in diameter, and whose altitude is the height of the fall; and the same force is exerted upon the shut-up orifice. These two pressures being equal, and acting in opposite directions, the arm will remain at rest; but as soon as the orifice is opened, the water will issue with a velocity due to the height of the fall. The pressure of the water upon the orifice will now be removed, and as the pressure upon the circular inch opposite

from the lower end of the column will acquire the same velocity of motion, from the uniform pressure of the thirty cubic inches which are above it, that one cubic inch let fall from the top would acquire in falling down to the level of the aperture, *viz.* such a velocity as in a contrary direction would throw or project it to the level from whence it fell, the weights and velocities in both these cases being equal, the products, or what we have called mechanical powers, will also be equal. We might therefore be led to suppose, that a cubic inch of water, let fall through a space of thirty inches, so as to impinge upon a solid body, would be capable of communicating thereto an equal motion or mechanical effect by collision, as if the same cubic inch had descended through the same space with a slower motion, and produced the effect gradually; for in both cases gravity acts upon an equal quantity of matter through an equal space.

It is true that the gravitating force acts a longer space of time upon the body that descends slowly, than upon the other which falls quickly; but this cannot occasion the difference in the effect: for we find by experiment, that an elastic body falling through any given space will, by collision upon another elastic body which is fixed, rebound nearly to the height from which it fell: or, by communicating its motion to a body equal to itself, will cause that body to ascend to the same height. On these principles we might conclude, as some authors have done, that whatever was the ratio between the power and effect in undershot wheels, the same would hold true in overshot, and indeed in all others.

However conclusive this reasoning may seem, it will appear, in the course of the following deductions, that the effect of the gravity of descending bodies is very different from the effect of the stroke, of such as are *non-elastic*, though generated by an equal mechanical power.

It is true that, in the cases we have above supposed, the power of the fall of water is the same; but the problem proposed to the engineer is, to obtain from it all or as much as possible of the power, and render it applicable to some useful purpose. We have already given our definition of *power*, that it is weight or matter compounded with motion. Now to obtain all the power from any stream of water, we must abstract from it all its weight and all its motion. In undershot wheels, or any others moved by the impulse of the water, we cannot come near this, because we have already shewn, that the greatest effect is produced, when the velocity of the wheel is two-fifths of the velocity of the moving water. The water, after it has finished its effect, is discharged with that velocity; hence it retains and carries away with it three-fifths of its original power. Neither can we obtain the full effect of the weight of the water, for another loss is sustained, in the change of figure which the water experiences, when it strikes the float-board. This is much greater than is usually supposed, in considering machines, although it must be familiar to any one who considers the resistance of a boat, or other body, when drawn through water. No weight is raised in these cases, unless the motion be rapid, (so as to raise a wave before the moving body;) but all the power is expended in changing the figure of the water, by dividing the particles, and putting them in new positions, so that the body can pass between them.

It is to this source that we must look, for the difference between two-fifths of the power, which we find is abstracted from the whole power of the water by an undershot-wheel, and one-third of the power, which is the utmost we can obtain by means of an undershot wheel.

In the other class of machines, which are actuated by the weight of water, we can obtain a much greater share of the power of the descending water. The weight of the water

is borne by the machine, which must therefore receive the whole weight of the water, and the loss is chiefly in the motion which the water still retains after departing from or quitting the machine; but as we are not confined, as in the former instance, to any fixed velocity of motion for the wheel, we may make it move almost as slowly as we please, so that the water will carry away with it a very small share of the velocity which it would have acquired by falling through the height of the fall. Indeed, if we could suppose a wheel to be without friction, and no water to leak or escape from those vessels, or parts of the wheel which contain the water, it would be possible to obtain an effect from it very nearly equal to the power.

Breast-Wheels.—These are very commonly called undershot wheels, because the water runs beneath the wheel, but improperly, because the water does not shoot against the floats of the wheel, or at least the principal power is derived from the weight of the water. A breast-wheel partakes of the nature of both an overshot and an undershot, and is constructed as is represented in *fig. 1. Plate I. of Water-wheels.* The lower part of the wheel is surrounded by a curved wall or sweep of masonry, which is made concentric with the wheel, and the float-boards of the wheel are exactly adapted to the masonry, so as to pass as near as possible thereto without touching it; and the side walls are in like manner adapted to the end of the float-board or sides of the wheel, the intention being, that as little water as possible shall be able to pass by the float-boards without causing the boards to move before it. The water is poured upon the wheel over the top of the breast at I, the efflux from the mill-dam R being regulated by the sluice or shuttle M, which is placed in the direction of a tangent to the wheel, and is provided with a rack N, and pinion P, by which it can be drawn up so as to make any required degree of opening, and admit more or less water to flow on the wheel.

The water first strikes on the float, and urges it by its impulse; but when the floats descend into the sweep, they form as it were close buckets, each of which will contain a given quantity of water, and the water cannot escape from these buckets except the wheel moves, at least this is the intention, and the wheel is fitted as close as it can be to the race with that view. Each of the portions of water contained in these spaces bears partly upon the wall of the sweep, and partly upon the floats of the wheel; and its pressure upon the floats, if not exceeded by the resistance, will cause the wheel to move; hence the action upon all the floats which are within the sweep of the breast is by the weight of the water alone; but the water is made to impinge upon the first float-board with some velocity, because the surface of the water in the dam K is raised considerably above the orifice beneath the shuttle where the water issues.

The upper part of the fall at I is rounded off to a segment of a circle called the crown of the fall, and the water runs over it. The lower edge of the shuttle when put down is made to fit to this curve, so as to make a tight joint; and in consequence when the shuttle is drawn up, the water will run between its lower edge and the crown in a sheet or stream which strikes upon the first float that presents itself, nearly in a direction perpendicular to the plane of the float-board, or of a tangent to the wheel. The float-boards of the wheel are directed to the centre, but there are other boards placed obliquely which extend from one float-board to the rim of the wheel, and nearly fill the space between one float-board and the next. These are called rising-boards, and the use of them is to prevent the water flowing over the float-board into the interior of the wheel; but the edges of these

these boards are not continued so far as to join to the back of the next float, because that would make all the boards of the wheel close, and prevent the free escape of the air when the water entered into the spaces between the floats.

As the water strikes with some force, the rising-board is very necessary, to prevent the water from dashing over the float-boards into the interior of the wheel.

This is the form of breast-wheel employed by Mr. Smeaton in the great number of mills which he constructed; but although he speaks of the impulse of the water striking the wheel, he always endeavoured to make the top of the breasting or crown of the fall as high as possible, so as to attain the greatest fall and the least of the impulsive action. All rivers and streams of water are subject to variation in height from floods or dry seasons, and in some this is very considerable; it was therefore necessary to make the crown I of the fall at such a height as that in the lowest state of the water R, it would run over the crown in a sheet of three or four inches in thickness, and work the wheel. When the water rose higher in the mill-dam, it would then have a pressure to force it through, and in that case would strike the wheel so as to impel it by the velocity.

Mr. Smeaton was well aware that the power communicated by this impulse was very small. In some cases, where the water was very subject to variation, he used a false or moveable crown, that is, a piece of wood which fitted to the crown I, and raised the surface thereof a foot or more, so as to obtain the greatest fall when the water stood at a mean height; but when the water sunk too low to run over this moveable crown, it could be drawn up to admit the water beneath it. This effect has since been produced in a more perfect manner by making the crown of the fall a moveable shuttle, to rise and fall according to the height of the water in the mill-dam, by which means the inconvenience before-mentioned is avoided.

Improved Breast-wheel, in which the Water runs over the Shuttle.—Fig. 7. is a section of one of this kind. A is the water which is made to flow upon the float-board B, and urges the wheel by its weight only, the water being prevented from escaping or flowing off the float-boards by the breast or sweep D D, and the side-walls which inclose the floats of the wheel. The upper part of the breast D D is made by a cast-iron plate, curved to the proper sweep to line with the stone-work. On the back of the cast-iron plate the moving shuttle *e* is applied; it fits close to the cast-iron so as to prevent the water from leaking between them, and the water runs over its upper edge. F is an iron groove or channel let into the masonry of the side-walls, and in these, the ends of the sliding shuttle are received; *f* is an iron rack, which is applied at the back of the shuttle, and ascends above the water-line where the pinion *g* is applied to it to raise or lower the shuttle. The axis of the pinion is supported in a frame of wood I I; *b* H is a toothed sector and balance-weight, which bears the shuttle upwards, or it might otherwise fall down by its own weight, and put the mill in motion when not intended. G is a strong planking, which is fixed across between the two side-walls, and retains the water when it rises very high, as in time of floods; but in common times the water rises only a few inches above the lower edge of the planking. When the shuttle is drawn up to touch this lower edge, the water cannot escape; but when the shuttle is lowered down, it opens a space *e* through which the water flows upon the float-boards of the wheel. This was the form first adapted for the falling-shuttle, but its construction has since been much improved.

Fig. 4. Plate II. is a section of the most improved form for a breast-wheel, taken from the Royal Armoury Mills, at

Enfield Lock, erected by Messrs. Lloyd and Ostel. The general description of this, is like the former, but it is constructed in a better manner, and unites strength with durability. The breast of masonry is surmounted by a cast-iron plate A $2\frac{1}{2}$ feet high, which is let into the masonry of the side walls at each end, and the lower part is formed with a flanch, by which it is bolted to the stone-breast at top. This plate is made straight at the back for the shuttle B to lie against, and it slides up and down. The ends of the gate are guided by iron groove pieces or channels which are let into the stone-work of the side walls, and being made wedge-like, they fix the ends of the cast-iron breast fast in its place. The grooves are not upright, but inclined to the perpendicular so much, that the plane of the gate is at right angles to a radius of the wheel drawn through the point where the water falls upon the wheel. D is a strong plank of wood, extended between the iron grooves just over the shuttle. When the shuttle is drawn up it comes in contact with the lower side of this piece of wood, and stops the water; but the piece D is fixed at such a height, that the water will run clear beneath it, unless its surface rises above its mean height.

The float-boards of the wheel do not point to the centre of the wheel, but are so much inclined thereto that they are exactly horizontal at the point where the water first flows upon them. In this way, the gravity of the water has its full effect upon the wheel, and the boards rise up out of the tail-water in a much better position, than if they pointed to the centre of the wheel; and this is more particularly observable when the wheel is flooded by tail-water penned up in the lower part of the race, so that it cannot run freely away from the wheel. The dimensions of this wheel are as follow:—Diameter 18 feet to the points of the floats, and 14 feet wide; the float-boards are 40 in number, each 16 inches wide, and each rising-board 11 inches wide. The wheel is formed of four cast-iron circles or wheels, each 14 feet 8 inches diameter, placed at equal distances upon the central axis, which is 14 feet 8 inches long between the necks or bearings, and 9 inches square; the bearing-necks are $9\frac{1}{2}$ inches diameter. The wheel is calculated to make four revolutions *per* minute, which gives near $3\frac{1}{2}$ feet *per* second for the velocity with which the float-boards move. The fall of water is six feet, and the power of the wheel, when the shuttle is drawn down one foot perpendicular, equal to 28-horse power.

Breast-Wheel with two Shuttles.—In this wheel the piece of wood marked D in the last figure, is fitted into the groove of the shuttle, and is provided with racks and pinions to slide up and down, independently of the lower shuttle. The intention of this is, to make the lower shuttle rise and fall, according to the height of the water, so that the water shall always run over the top of it, in the proper quantity to work the mill with its required velocity, whilst the upper shuttle is only used to stop the mill by shutting it down upon the lower shuttle, and preventing the water from running over it. This plan is used when the mill is to be regulated by a governor, or machine to govern its velocity; in that case the governor is made to operate upon the lower shuttle, and will raise it up, or lower it down, according as the mill takes too much or too little water, and this regulates the supply; but the upper shuttle is used to stop the mill, and by this means the adjustment of the lower shuttle is not destroyed, but when set to work again, it will move with its required velocity. Fig. 3. Plate II., *Water-wheels*, is a section of one of the water-wheels at the cotton-mills of Messrs. Strutt, at Belper, in Derbyshire. The width of this wheel is very great, and to render the shuttles A B firm, a strong

grating of cast-iron, is fixed on the top of the breast K, and the shuttles are applied at the back of the grating E, so as to slide up and down against it, the strain occasioned by the pressure of the water being borne by the grating. The lower shuttle is moved by means of long screws, *a*, which have bevelled wheels, *b*, at the upper ends, to turn them, by a connection of wheel-work with the wheel-work of the mill. The upper shuttle, A, is drawn up or down by racks and pinions, *c*, which are turned by a winch, or handle. The bars of the grating E are placed one above the other, like shelves, but are not horizontal; they are inclined, so that the upper surfaces of all the bars form tangents to an imaginary circle of one-third the diameter of the wheel described round the centre thereof. These bars are not above half an inch thick, and the spaces between them are $2\frac{1}{2}$ inches. The bars are of a considerable breadth, the object of them being to lead the water, with a proper slope, from the top of the lower shuttle A to flow upon the floats of the wheel. This disposition allows the shuttles to be placed at such a distance from the wheel as to admit very strong upright bars of cast iron to be placed between the wheel and the shuttles, for the shuttles to bear against, and prevent them from bending towards the wheel, as the great weight of water would otherwise occasion them to do. These upright bars are very firmly fixed to the stone-work of the breast at their lower ends, and the upper ends are fastened to a large timber, D, which is supported at its ends in the side walls, and has a truss-framing applied to the back of it, like the framing of a roof, to prevent it from bending towards the wheel. The upright bars are placed at distances of five feet asunder, so as to support the shuttles in two places in the middle of their length, as well as at both ends; and large rollers are applied in the shuttle, where it bears against these bars, to diminish the friction, which would otherwise be very great.

These precautions will not appear unnecessary when the size of the work is known. The wheel is $21\frac{1}{2}$ feet in diameter, and 15 feet broad; the fall of water is 14 feet, when it is at a mean height; the upper shuttle is $2\frac{1}{2}$ feet high, and 15 feet long; the lower shuttle is 5 feet high, and the same length, so that it contains 75 square feet of surface exposed to the pressure of the water: now taking the centre of pressure at two-thirds of the depth, or $3\frac{1}{3}$ feet, we find the pressure equal to that depth of water acting on the whole surface; that is, the weight of $3\frac{1}{3}$ cubic feet of water = 208 lbs. bears on every square foot of surface, which is equal to 15,600 lbs., or near 7 tons on the lower shuttle only; but if we take the two shuttles together, the surface is 112 square feet, and the mean pressure 312 lbs. upon each, or 16 tons in the whole. The wheel has forty float-boards pointing to the centre. The wheel is made of cast-iron. There are two wheels of the dimensions above stated, which are placed in a line with each other, and are only separated by a wall which supports the bearings; for they work together as one wheel, and the separation is only to obviate the difficulty of making one wheel of such great breadth as 30 feet, though this is not impossible, for there is a wheel in the same works 40 feet in breadth, but it is of wood and not in iron, framed in a particular manner, as we shall soon describe.

Mr. Buchanan's Bucket Water-Wheel for a low Fall.—We have already shewn, that where water can be made to act on a wheel by weight, it is much more effectual than when the same water is made to act by impulse; and we shall shew this more fully in speaking of overshot-wheels.

Where the fall is less than half the diameter of the wheel, if the buckets are made in the usual form of the buckets for overshot-wheels, the difficulty of filling them

with water, and the short time they are able to retain the water, are such great defects, that in such cases breast-wheels, with open float-boards, such as we have described, have been found in practice to be more advantageous than bucket-wheels.

Mr. Buchanan suggests, that, by adopting another form of the buckets, they might be made as to be easily filled, and at the same time capable of retaining the water in a situation to produce nearly its full effect altogether by weight, on a low fall.

In a wheel of this construction, contrary to the usual practice, the water must be poured into the buckets from within the circle of buckets instead of from without the circle of buckets. How the filling of the buckets from within can be accomplished may not at first be obvious; but it may be done without the pentrough, which supplies the water, making any interference with the arms of the wheel, if it is constructed as shewn in *figs. 4. and 5. Plate I. Water-wheels.* *Fig. 4.* is an horizontal section of the wheel, and plan of the pentrough; and *fig. 5.* an elevation of the water-wheel.

The buckets in the figure, empty themselves by means of apertures on the outside of the wheel, which are the whole length of the buckets, but no wider than just sufficient to discharge the water from the buckets when they arrive at the bottom of the wheel, and before they begin to ascend. A A is the pentrough, into which the supply of water is conducted. From B to C a part of the wheel is represented, with the shrouding removed, to shew the form of the buckets, and the situation of the water in them; *a, a, a,* are the apertures by which the water escapes from the buckets; *b* the aperture by which the water enters from the pentrough to the buckets. The plan, *fig. 4.*, shews, that the arms, N N, of the wheel, and the circular rims which support the buckets, occupy only a small part of the breadth of the circular ring of buckets M; so that about one-third of the length of the buckets at each end is exposed on the inside of the circle, and against these parts the penstock is applied, as shewn at A A, and the arms and rim of the wheel, move clear of it; but the buckets, as they pass, receive water, which flows in a continual stream at the orifices, *b, b,* of the pentrough; the buckets there become filled from the inside. The partition-boards or plates which form the buckets are represented by the white lines in *fig. 5.*, and are so shaped, that they will retain nearly the whole of the water until they arrive at the lowest *a*; the water then begins to escape, and by the time that each bucket arrives at the lowest point of the wheel, it will have discharged all the water, and will rise up empty.

This is a truly ingenious contrivance; but we fear that in the execution it would present many difficulties, particularly the ring of buckets M, which could not, we think, be so firmly affixed, supported by the narrow bearing of the two rings and arms N, as to preserve their circular figure for any great length of time; and any bending or warping of such a heavy mass as a water-wheel will soon destroy it. Neither is the advantage which could be derived from receiving the water in close buckets, instead of open float-boards, so great as is generally imagined.

On the Power and Effect of Breast-wheels.—We shall fully examine the different effects of the power of water, when acting by its impulse and by its weight, under the title of *overshot-wheels.* In breast-wheels of the common construction, the effects of impulse and weight are combined; but what is there described being carefully attended to, the application of the same principles in these combined cases will be easy.

All kinds of machines, where the water cannot descend through a given space, unless the wheel moves therewith, are to be considered as of the same nature with overshot-wheels, and equal in power and effect to an overshot-wheel, in which the perpendicular height that the water descends from is the same. All those machines that receive the impulse or shock of the water, whether in an horizontal, perpendicular, or oblique direction, are to be considered of the same nature as undershot-wheels. Therefore, in a wheel which the water strikes at a certain point below the surface of the water in the mill-dam, and after that descends in the arc of a circle, pressing by its gravity upon the floats of the wheel, the power will be equal to the effect of an undershot-wheel, whose fall is equal to the difference of level, between the surface of the reservoir and the point where it strikes the wheel, added to that of an overshot, whose height is equal to the difference of level between the point where it strikes the wheel and the level of the tail-water.

It is here supposed that the wheel receives the shock of the water at right angles to its radii, and that the velocity of its circumference is properly adapted to receive the utmost advantage of both these powers; otherwise a reduction must be made on that account.

Mr. Ostel, an experienced engineer, informs us, that the velocity of the water-wheel's circumference should always be between three and four feet *per second*; but he has not been able to determine which of these two velocities is the best, except in cases where a wheel is subject to be flooded by tail-water; and in that case four feet *per second* is best. Mr. Smeaton advised $3\frac{1}{2}$ feet.

On overshot Water-Wheels.—An overshot-wheel is simply a circular ring of open buckets, so disposed round the circumference of a vertical wheel, as to receive the water from a spout placed over the wheel in such a manner, that the buckets on one side of the wheel shall be always loaded with water, whilst the other side is empty: in consequence, the loaded side will cause it to descend; and by this motion the water runs out of the lower buckets, while the empty buckets of the rising side of the wheel, in their turn come under the spout, and are filled with water.

A machine so simple does not appear to present any difficulties in its execution, which should require any application of theoretic reasoning to remove them; but in reality it is a matter of some delicacy to construct a wheel in such a manner as to obtain the greatest effect from a given fall of water.

It is probable, that the earliest overshot water-wheels consisted of a number of wooden boxes or bowls, fastened on the circumference of the wheel; but these would soon give place to a better mode of construction, in which the circumference of the wheel being surrounded by a circular ring at each side, the space between them was divided into separate buckets by partition-boards. These partitions did not point to the centre of the wheel in the direction of radii, but were inclined thereto nearly in an angle of forty-five degrees. By this means, the water which issued from the spout of the trough above, nearly in an horizontal direction, as a tangent to the wheel, would run into the buckets, and fill them as they arrived in succession at the top or highest point of the wheel; but as the buckets changed their position by the descending-motion of one side of the wheel, they would become inclined, and the water contained in the buckets would begin to run over the edges of the partitions between the buckets, and by the time the bucket arrived at the bottom point of the wheel, the whole of the water would be run out and leave the bucket empty, and they would remain empty whilst they ascended on the opposite side of the wheel. By this

means, a constant preponderance of one side of the wheel would be kept up by the water falling into the buckets at the top of the wheel, and flowing from it at the bottom.

The points chiefly to be considered in constructing an overshot-wheel are, first, that the water shall be applied on the circumference of the wheel, so as to be incapable of descending without communicating motion to the wheel, until the water has descended to its lowest position, and that it shall then quit the wheel entirely; secondly, that the utmost height of fall shall be attained and usefully employed; and thirdly, that the load or resistance to the motion of the wheel shall be so adapted and proportioned to the weight of water which is applied in the descending-buckets of the wheels, that the wheel will move slowly; because we have before shewn, that whatever velocity the wheel moves with, so much velocity the water must retain when it quits the wheel, and will thus carry away some power with it.

We shall now proceed to consider all the particulars which contribute to the attainment of these objects, taking Mr. Smeaton for our guide, and only adding such observations as appear necessary to render his maxims more clear.

I. *On the maximum Effect which can be obtained from a Fall of Water by Means of an overshot-Wheel.*—The effective power of the fall of water must be reckoned upon the whole descent, because it must be raised that height, in order to be in a condition to produce the same effect a second time. The ratio between the powers of the falling water so estimated, and the mechanical effects produced by the wheel at the maximum, deduced from the mean of several of Mr. Smeaton's experiments, is as 3 to 2 nearly. We have before, in our observations upon the effects of undershot-wheels, shewn that the general ratio of the power to the effect, when greatest, was 3 : 1. The effect, therefore, produced by an overshot-wheel, under the same circumstances of quantity and fall of water, is at a medium, double that produced by an undershot. From this, it appears that non-elastic bodies, when acting by their impulse or collision, communicate only a part of their original power; the other part being spent in changing their figure in consequence of the stroke.

The ratio of the power to the effect, computed upon the height of the wheel only, was, at a maximum, as 10 : 8, or as 5 : 4 nearly, because Mr. Smeaton made the wheel of a less height than the fall of water, in order to allow some run or descent of the water through the spout or trough, which conducted it into the buckets of the wheel. We find the ratio, between the power and effect, to continue the same, in cases where the constructions are similar; hence we must infer, that the effects, as well as the powers, are as the quantities of water and perpendicular heights multiplied together respectively.

II. *On the most proper Height of the Wheel, in Proportion to the whole Descent.*—The preceding observation shews, that the effect which can be obtained from the same quantity of water, descending through the same perpendicular space, is double when it is made to act by its gravity upon an overshot-wheel, to what could be obtained from it when made to act by its impulse upon an undershot-wheel.

Hence it follows, that the higher the wheel is, in proportion to the whole descent, the greater will be the effect; because an overshot-wheel depends less upon the impulse of the water when it first strikes the wheel, and more upon the gravity of the water in the buckets. The water which is conveyed into the buckets can produce very little effect by its impulse, even if its velocity be great; both on account of

the obliquity with which it strikes the buckets, and in consequence of the loss of water occasioned by a considerable quantity of fluid being dashed over their sides. Instead, therefore, of expecting an increase of effect from the impulse of the water occasioned by its fall through some part of the whole height, we should cause it to act through as much as possible of this height by its gravity, by making the diameter of the wheel as great as possible. But a disadvantage attends even this rule; for if the water is conveyed into the buckets with a very small velocity, which must be the case when the diameter of the wheel equals the height of the fall, the velocity of the wheel will be retarded by the impulse of the buckets striking against the water, in order to put it in motion, and much power would be lost by the water dashing over them. In order, therefore, to avoid all inconveniences, the distance of the spout from the receiving-bucket should, in general, be about two or three inches, that the water may be delivered with a velocity a little greater than that of the wheel; or, in other words, the diameter of an overshot-wheel should be two or three inches less than the greatest height of the fall; and yet it is no uncommon thing to see the diameters of these wheels scarcely one-half of that height. In such a construction, the loss of power is prodigious.

It is always desirable that the water should have somewhat greater velocity, than the circumference of the wheel in coming thereon, otherwise the wheel will not only be retarded by the buckets striking the water, but thereby dashing a part of it over so much of the power is lost.

The velocity that the circumference of the wheel ought to have, will be known by what we shall say next, and the depth of column requisite to give the water its proper velocity, is easily computed from the rules and tables given in this article, and will be found much less than what is generally supposed.

This maxim obliges us to use a wheel, whose diameter is nearly equal to the whole fall; but we shall not gain any thing by employing a larger wheel. It is true, we could then apply the water upon a part of the circumference where the weight will act more perpendicularly to the radius, but we should lose more, by the necessity of discharging the water at a greater height from the bottom, because the water, in all cases, begins to run out of the buckets long before they arrive at the bottom of the wheel.

Suppose the buckets of both wheels equally well constructed in either case, whether the wheel is only as high as the fall, or of a greater height, then the heights above the bottom, where they will discharge the water, will increase in the proportion of the diameter of the wheel. That we shall lose more by this, than we gain by a more direct application of the weight, is plain without any further reasoning, by taking the extreme case, and supposing our wheel enlarged to such a size, that the useless part below would be equal to our whole fall. In this case, the water would be spilled from the buckets as soon as it is delivered into them. All intermediate cases, therefore, partake of the imperfection of this. It was the object of Mr. Buchanan's bucket-wheel, which we have already described, to avoid this difficulty, and employ a height of fall which bore only a small proportion to the whole height of the wheel. This observation necessarily leads us to consider the best form for the buckets.

III. *On the best Form for the Buckets of overshot Wheels.*—It is impossible to construct the buckets so that they will remain completely filled with water till they reach the bottom of the wheel: indeed, if the buckets were formed by partitions directed to the axis of the wheel, the whole water

must run out by the time they have descended to the level of the axis; and, in consequence, there must be a great diminution in the mechanical effect of the wheel. Millwrights have, therefore, turned their chief attention to the determination of a form for the buckets which shall enable them to retain the water through a great portion of the circumference of the wheel. An inspection of *figs. 2 and 3* will shew at once the proper form which has been established by long practice. These are called elbow-buckets, because each partition is formed by two boards, which are put together with an angle or elbow. The rule for setting these out is, to divide the wheel into the number of buckets it is intended to have; then take four-fifths of the space or interval between two partitions for the depth of the shrouding, that is, the breadth of the circular rings at the sides of the wheel, which form the ends of the buckets, and are called the shrouds; whilst the planking, which forms the bottom of all the buckets, is called the sole of the wheel. That board of each partition which is in the direction of a radius to the wheel, rises from the sole half the depth of the shroud; the other board of the bucket is so inclined, that its outer end shall be advanced beyond the line of the next radius-board, if it was produced.

It is a great advantage to make the partitions of the buckets thin, particularly the edges of the partitions, which will meet and divide the stream of water flowing upon the wheel; and if these edges are not made sharp, they will splash the water about; the edges are, therefore, finished by iron-plate, or it is better to make all the inclined parts of the partition of iron-plate. The greater number of buckets, and the shallower they are, the more regularly the wheel will act. The limits are, that the mouths of the buckets shall be of such width as to allow the air to escape, at the same time that the stream of water flows in; and also that the breadth of the wheel shall not be extravagantly great, to make its buckets contain as much water as would produce the power required from the wheel.

The loss of water, at the lower part of the wheel, will very much depend upon the proportion of water which is poured into each bucket. It is evident, that if the buckets, of whatever form they are made, were totally filled when at the top of the wheel, they must begin to spill the water immediately when they departed from that position. But, on the other hand, if only a part of the content of each bucket is filled with water, then it will bear a greater degree of inclination, and be a longer time before the water will begin to spill from the bucket. This is a reason for making large buckets, and filling only a part of their contents. In practice a medium must be struck between these contending circumstances, and the wheel will act to advantage.

It has been proposed to apply another bend to the partition-boards of each bucket which shall be beyond the inclined board that we have described, and shall be concentric with the rim of the wheel, in the same manner as is represented in Mr. Buchanan's wheel, *fig. 5*. It is true that this form would retain the water from spilling for a longer time, and thus be an advantage; but it is not favourable for admitting the water into the buckets when at the top of the wheel.

The inclined boards, when made as we have described, may be exactly in the line of the stream of water, which issues from the spout when it passes beneath such stream; and in this way, if the edge of the inclined board is made thin, there will be as little splashing of the water as possible. But by the addition of another part to the edge of the partition, which is concentric to the circle of the wheel, the stream of water cannot be made to proceed exactly in the line

line of the partition, and will therefore splash the water. The splashing may appear immaterial, but it is in reality very prejudicial, because the broken water fills the mouth of the bucket, and prevents the air from getting out readily, and it is for this reason that it is very necessary to allow so much of the fall above the height of the wheel, as will make the water run into the buckets, with a little greater velocity than the motion of the wheel.

Dr. Robinson, in the *Encyclopædia Britannica*, described a plan for the buckets of an overshot wheel, which was invented by Mr. Robert Burns, millwright, and executed by him at a cotton-mill in Scotland: it is shewn in *fig. 5. Plate II. Water-wheels*. In this way, the wheel has two ranks of buckets, one within the other. The buckets consist of a partition A B, in the direction of a radius of the wheel, which is joined to another B C, inclined to that, and also to a third C D, which is concentric with the rim of the wheel.

The bucket is divided into two, by a partition L M, also concentric with the rim of the wheel, and so placed as to make the inner and outer portions of the bucket nearly of equal capacity. It is evident, without any farther reasoning, that this partition will enable the double bucket to retain its water much longer than the single one could. When they are filled only one-third, they retain the whole water at eighteen degrees from the bottom of the wheel, and they retain half of the water at eleven degrees. The only objection is, that they do not admit the water quite so freely as buckets of the common construction.

This arises from the air, which must find its way out to admit the water, but is obstructed by the entering water, and occasions a great spluttering at the entry. This may be entirely prevented, by making the spout considerably narrower than the wheel, and will leave room at the two ends of the buckets for the escape of the air. It was found in practice, that a slow moving wheel, allowed one half of the water to get into the inner buckets, especially when the partitions which form the inner buckets, did not altogether reach the radius drawn through the lip D of the outer bucket. The doctor considers this as a very great improvement of the bucket-wheel; and when the wheel is made of a liberal breadth, so that the water may be very shallow in the buckets, it seems to carry the performance as far as it can go. Mr. Burns made the first trial on a wheel of twenty-four feet diameter, and its performance is manifestly superior to that of the wheel which it replaced, and which was a very good one. It has also another valuable property. When the supply of water is very scanty, a proper adjustment of the stream of water issuing from the spout, will direct almost the whole of the water into the outer buckets; which, by placing it at a greater distance from the axis, makes some addition to its mechanical energy.

IV. *Concerning the proper Velocity of the Circumference of an overshot Wheel, in order to produce the greatest Effect.*—If a body of water is let fall freely from the surface of the water in the upper reservoir to the bottom of the descent, it will take a certain time in falling; and in this case, the whole action of gravity will be spent in giving the water a certain velocity. But if this water in falling is intended to act upon some machine, so as to produce a mechanical effect, the falling water must be retarded, because a part of the action of gravity is then spent in producing the effect, and the remainder only will give motion to the falling water, which motion it will retain, after it has quitted the machine. On this principle, the slower a body descends the greater portion of the action of its gravity can be applied to pro-

duce mechanical effect, and in consequence the greater that effect will be.

If a quantity of water falls from a stream, into each bucket of an overshot-wheel, it is there retained until the wheel, by moving round, discharges it. Now, the slower the wheel moves, the more water each bucket will receive, because it remains a longer time beneath the spout, so that what is lost in the speed with which the wheel moves, is gained by the pressure of a greater quantity of water acting in the buckets at once; and if considered only in this light, the mechanical power of an overshot-wheel to produce effects will be equal, whether it moves quick or slow. The popular reasoning adduced to prove this has been of the following kind. Suppose that a wheel has thirty buckets, and that four cubic feet of water are delivered in a second on the top of the wheel, and discharged, without any loss by the way, at a certain height from the bottom of the wheel.

It is clear that this stream will supply the same quantity, whatever is the rate of the wheel's motion; and the buckets must be of a sufficient capacity to hold all the water which falls into them when the wheel moves very slow. Suppose this wheel employed to raise a weight of any kind, for instance to draw a basket of coals out of a deep pit or mine, and that the rope winds upon a barrel of such size that the basket will be drawn up with the same velocity as the water in the buckets descends. Suppose, further, that the wheel will make four revolutions in a minute, or one turn in fifteen seconds, when the load or weight in the basket which forms the resistance to the motion of the machine is one-third of the load of water contained in the buckets of the wheel.

Now, during the time of one revolution, sixty cubic feet of water will have flowed into the thirty buckets, and each have received two cubic feet. In this case, the basket may contain a weight equal to twenty cubic feet of water, which weight will be drawn up a height equal to one circumference of the wheel, during one turn of the wheel, or in fifteen seconds of time.

Now suppose the machine so loaded, by making the basket more capacious, that the wheel can only make two turns in a minute, or one turn in thirty seconds, then each descending bucket of the wheel will receive four cubic feet of water. If the basket contained a double weight, *viz.* equal to forty cubic feet, the effect produced by the machine would be the same as before, because the velocity is only one half; but we find in practice, that it will raise more than in this proportion when it moves slower, for if we attend to what we have just observed of the falling body, we find that so much of the action of gravity as is employed in giving motion and velocity to the wheel and water therein, must be subtracted from its pressure upon the buckets. The product made by multiplying the number of cubic inches of water which act on the wheel at once by its velocity, will be the same in all cases; yet, as each cubic inch, when the velocity is greater, presses more lightly upon the buckets than when the velocity is less, the power of the water to produce effects will be greater in the less velocity than in the greater. This leads us to the general rule, that the less the velocity of the wheel, the greater will be the effect produced by any given quantity, and fall of water.

A confirmation of this doctrine, together with the limits it is subject to in practice, is a matter of experiment and observation which has been ably decided by Mr. Smeaton. The velocity of the wheel should not be diminished, further than what will produce some solid advantage in point of power; because, as the motion is slower, the buckets must be made larger, that the increase of their weight may compensate

penfate for the flownefs of their motion. The wheel being thus more loaded with water, the ftreffs upon every part of the work will be increafed in proportion.

The beft rule for practice will be, to make the velocity of the circumference a little more than three feet in a fecond.

Experience confirms, that this velocity of three feet in a fecond, is applicable to the greateft overfhot wheels as well as the fmalleft; and all other parts of the work being properly adapted to this velocity, the fall of a given quantity of water, will produce very nearly the greateft effect poffible. But it is alfo certain from experience, that large wheels may deviate further from this rule before they will lofe their power, by a given aliquot part of the whole, than fmall ones can be admitted to do; for inftance, a wheel of twenty-four feet high may move at the rate of fix feet *per* fecond, without lofing any confiderable part of its power. This may perhaps be accounted for, when we confider how fmall a proportion of the whole fall is requifite to give the water the proper velocity which the wheel ought to have; whilft in a fmall wheel, the fame height muft be allowed for that purpofe, and confequently, a greater proportion of the whole height. On the other hand, Mr. Smeaton tells us, that he had feen a wheel of thirty-three feet diameter that moved very ftadily and well, with a velocity but little exceeding two feet *per* fecond.

There is a natural wifh to fee a machine move briskly; it has the appearance of activity: but a very flow motion always looks as if the machine was overloaded. For this reafon, mill-wrights have always yielded flowly, and with reluctance, to the advice of Mr. Smeaton, but they have yielded; and we now fee them adopting maxims of conftruftion more agreeable to found theory, that is, making their wheels of great breadth, and loading them with a great deal of work. The reluctance to adopt this fystem did not arife folely from prejudice, but from a real inconvenience attending the flow motion of the wheel when the refiftance which is oppofed to its motion, and which is the caufe that it moves flowly, is not uniform in the different parts of a revolution.

In all machines, there are fmall inequalities of action which are unavoidable; and in fome machines very great inequalities arife, from the intermitting motions of cranks, flampers, and other parts which move unequally or reciprocally. When a water-wheel is employed to give motion to fuch machines, it may be fo refifted or loaded, as to be nearly in equilibrio with its work, in the moft favourable pofition of the parts of the machine; but when thefe change into a lefs favourable pofition, the machine may flop the wheel altogether, or at all events hobble, and work very irregularly. And for the fame reafon that a water-wheel accommodates its motion very quickly to the refiftance it is to overcome, fo all tendency to irregular motion is increafed. A wheel, when its load is increafed, moves more flowly, and receives more water into each bucket; thereby taking to itfelf a weight of water equal to overcome its load, and on the other hand by moving quicker, it takes lefs water into each bucket when the load is diminished. But thefe changes do not take place infтанtaneously, becaufe it can be only in the moment that each bucket paffes beneath the fream, that the fhare of water it fhall have, will be influenced by the rate of the wheel's motion. When a bucket is once filled it continues with that charge until it arrives at the bottom of the wheel.

This felf-regulating property of the wheel can only apply in cafes of fmall and permanent changes of refiftance,

for it always comes too late to correct fudden and confiderable changes in the refiftance; then it acts in the contrary direction. Suppofe, for inftance, an overfhot wheel is employed to work a fingle pump by means of a crank, the refiftance of this machine will be continually varying; it will be nothing during one-half of the period of the revolution when the pump is not drawing any water, and during the other half it will be in a confant ftate of increafe and diminution. Now, during the time this wheel has nothing to do, it will turn round very quickly, and therefore each bucket will receive very little water; confequently, when the wheel comes to be refifted, the wheel will have fo little water in its buckets, that it will perhaps be quite ftopped: in this cafe, the bucket beneath the fpout will receive water until it is quite full, and then the water will run over and fill fo many of the buckets beneath it, as to put the wheel in motion flowly; in confequence, the fucceeding buckets will receive a large fhare of water during the half revolution when the pump makes its ftroke; but when this is finifhed, and the refiftance ceafes, the wheel being well loaded with water, will in confequence move very rapidly for a half revolution, and its buckets will receive very little water.

This is indeed an extreme cafe of irregular refiftance, and muft be remedied by applying two pumps inftead of one, or a balance-weight, or a fly-wheel; but the fame principle will apply in cafe of fmall irregularities. In all cafes, the refiftance muft be reduced to a great degree of uniformity, before a water-wheel can be applied to it with advantage, particularly if the wheel is intended to move flowly, with a view of obtaining the greateft power, the irregularities will then have more ferious confequences.

A little more velocity enables the machine to overcome thofe increafed refiftances by its *inertia*, or the great quantity of motion inherent in it. Great machines poffefs this advantage in a fuperior degree, and will confequently work ftadily with a fmall velocity. In all cafes, the machine muft have fo much moving matter in it as is fufficient to overcome the irregularities, and regulate the motion of the wheel. If this is not already found in the machine, as in the mill-ftones of a corn-mill for inftance, the weight muft be placed in the water-wheel itfelf, or in a fly-wheel applied for the purpofe.

Mr. Bucharan meafured the quantity of water which a cotton-mill required, when going at its common velocity; and when going at half that velocity. The refult was, that the laft required juft half the quantity of water which the firft did. In the experiments, the quantities of water were calculated from the depth of water and apertures of the fluires.

From which experiments, he inferred that the quantity of water neceffary to be employed in giving different degrees of velocity to a cotton-mill, muft be nearly as the velocity. The water from the cotton-mill on which he made the obfervation, falls a little below it, into a perpendicular-fided pond, which ferves as a dam for a corn-mill. By meafuring the time which the water took to rife at a certain height in that pond, he determined the expediture of water when the corn-mill moved at its common velocity; and alfo when it moved at nearly half that velocity.

The refult of thefe experiments approached very nearly to the former, and all the differences could be accounted for, by a fmall degree of leakage, which took place at the fluires on the lower end of the pond; and the time being greater when the mill moved flowly, the leakage would of courfe be greater.

In these experiments, the motion of the water-wheel being exactly proportioned to the quantity of water expended, the load upon the wheel must have been equal when it moved quick or slow, that is to say, the buckets must have been equally filled when the wheel moved at its ordinary motion, or at half that motion.

The effect, therefore, of letting more water on a wheel when the resistance continues the same, is not to lodge a greater quantity in each of the buckets, but to supply the same quantity to each bucket when the wheel is in a greater motion.

The greatest velocity that the circumference of an overshot wheel can acquire, depends jointly upon the diameter or height of the wheel, and the velocity of falling bodies; for it is plain, that the velocity of the circumference can never be greater, than to describe a semicircumference, in the time that a body let fall from the top of the wheel would descend through its diameter, nor indeed quite so great; as a body descending through the same perpendicular space cannot perform its course in so small a time, when passing through a semicircle, as would be done in a perpendicular line. Thus, if a wheel is sixteen feet one inch diameter, a body will fall through the line of its diameter in one second: this wheel, therefore, can never arrive at a velocity equal to the making one turn in two seconds. An overshot wheel can never come near this velocity, for when it acquires a certain speed the greatest part of the water is prevented from entering the buckets; and the rest, at a certain point of its descent, is thrown out again by the centrifugal force. The velocity, when this action will begin to take place, depends in a great degree upon the form of the buckets as well as other circumstances; so that the utmost velocity that an overshot wheel may be capable of is not to be determined generally; and indeed the knowledge of it is not at all necessary in practice, because a wheel, in such case, would be incapable of producing any mechanical effect.

V. *On the proper Load for an overshot Wheel, in order that it may produce a maximum Effect.*—The maximum load or resistance for an overshot wheel, is that which will reduce the circumference of the wheel to its proper velocity, of three or three and a half feet *per* second; and this will be known, by dividing the effect it ought to produce in a given time, by the space intended to be described by the circumference of the wheel in the same time; the quotient will be the resistance to be overcome at the circumference of the wheel, and is equal to the load required, the friction and resistance of the machinery included.

VI. *On the greatest Load that an overshot Wheel can overcome.*—The greatest load an overshot wheel can overcome depends upon the magnitude of the buckets; and the resistance which will stop the wheel, must be equal to the effort of all the buckets in one semicircumference, when quite filled with water.

The structure of the buckets being given, the quantity of this effort may be assigned, but is not of much importance in practice, as in this case also, the wheel loses its power; for though the water makes the utmost exertion of gravity upon the wheel, yet, being prevented by a counterbalance from moving at all, it is not capable of producing any mechanical effect, according to our definition. An overshot wheel, generally ceases to be useful before it is loaded to that pitch, for when it meets with such a resistance as to diminish its velocity to a certain degree, its motion becomes irregular; yet this never happens until the velocity of the circumference is reduced to less than two feet *per* second, where the resistance is equable, as appears not

only from the preceding specimen, but from experiments on larger wheels.

VII. *Construction of the Pentrough for supplying the Water to overshot Wheels.*—We have hitherto spoken of the stream of water, as if it issued from a spout nearly in an horizontal direction, or with only so much inclination as will make the line of the stream correspond with the direction of the oblique part of the bucket-board. This is the ancient, and still the common way; Mr. Smeaton's, which is a much better, is shewn in *fig. 2. Plate I. Water-wheels.* G represents the pentrough through which the water flows, and F F strong cross-beams on which it is supported; the wheel is situated very close beneath the bottom of the trough, as the figure shews. E E are two arms of the wheel, which are put together, as shewn in *fig. 7.* DB is the wooden rim of the wheel; the narrow circle beyond this is the section of the sole planking, and on the outside of this the bucket-boards are fixed as the figure shews; one of the bottom boards, *b*, of the trough at the end is inclined, and an opening is left between that end and the other boards of the bottom, to let the water pass through; this opening is closed by a sliding shuttle, *c*, which is fitted to the bottom of the trough, and can be moved backwards and forwards by a rod, *d*, and lever, *e*, which is fixed into a strong axis *f*; this axis has a long lever on the end, which, being moved by the miller, draws the shuttle along the bottom of the trough, and increases or diminishes the aperture through which the water issues. The extreme edge of the shuttle is cut inclined, to make it correspond with the inclined part *b*, and by this means it opens a parallel passage for the water to run through, and this causes the water to be delivered in a regular and even sheet; and to contribute to this the edges of the aperture where the water quits it, are rendered sharp by iron plates; the shuttle is made tight where it lies upon the bottom of the trough by leather, so as to avoid any leakage when the shuttle is closed. When the wheel is of considerable breadth, the weight of the water might bend down the middle of the trough until it touched the wheel; to prevent this, a strong beam, O, is placed across the trough, and the trough is suspended from this by iron bolts which pass through grooves in the shuttle, so that they do not interfere with the motion of the shuttle.

Fig. 3. of the same plate is an overshot wheel, for which Mr. Nouaille took a patent in 1813; he recommends that the water-wheel be made the full height of the fall of water, and that the water be applied upon the wheel at 53 degrees from the vertex. The pentrough is made nearly on the same plan as Mr. Smeaton's. O R is the trough, *bg* the end inclined in the direction in which the water is intended to be directed, *f* the shuttle, sliding horizontally on the bottom of the trough, *cde* the lever for drawing the shuttle, to which motion is given by a regulating screw *a* and nut *b*.

Fig. 9. Plate II. Water-wheels, is the method of laying on water, which has for several years been in common use in Yorkshire and the north of England. In this the water is not applied quite at the top of the wheel, but nearly in the same position as the last described; but the advantages of this wheel over all others is, that the water can be delivered at a greater or less height, according to the height at which the water stands in the trough; but in all the preceding methods if the water is subject to variations of height, as all rivers are, then the wheel must be diminished, so that in the lowest state of the water it will stand a sufficient depth above the orifice in the bottom of the trough to issue with a velocity rather greater than the motion of the wheel. In this case, when the water rises to its usual height, or above it, the increase of fall thus obtained is very little advantage to the wheel; the improved wheel

wheel can at all times take the utmost fall of the water, even when its height varies from three to four feet. A A is the pentrough made of cast-iron; the end of it is formed by a grating of broad flat iron bars, which are inclined in the proper position to direct the water through them into the buckets of the wheel. The spaces between the bars are shut up by a large sheet of leather, which is made fast to the bottom of the iron trough at *a*, and is applied against the bars; and the pressure of the water keeps it in close contact with the bars, so as to prevent any leakage. This is the real shuttle, and to open it so as to give the required stream of water to the wheel, the upper edge of the leather is wrapped round a smaller roller *b*; the pivots at the ends of this roller are received in the lower ends of two racks, which are made to slide up and down by the action of two pinions fixed upon a common axis which extends across the trough; this axis being turned, raises up or lowers down the roller, and the leather shuttle winds upon it as it descends, or unwinds from it as it ascends, so as to open more of the spaces between the bars, or close them as it is required. In order to make the roller take up the leather, and always draw it tight, a strap of leather is wound round the extreme ends of the rollers, beyond the part where the leather shuttle rolls upon it. These straps are carried above water and applied on wheels, which wind them up with a very considerable tension by the action of a band and weight wrapped on the circumference of a wheel, which is on the end of the axis of those wheels.

The water runs over the upper side of the roller, and flows through the spaces between the grating into the buckets of the wheel; the descent of the water passing through the bars, and afterwards in falling before it strikes the bottom of the bucket, is found fully sufficient to produce the necessary velocity of the water, for a fall of four inches produces a velocity of more than four feet *per* second.

We recommend this as the best method of applying the water, as we see in all other forms that a much greater portion of the fall is given up in order to make the water flow into the wheel; not that any such depth as is commonly given is at all necessary, but the aperture in the trough must be placed so low that the water will run through it in the very lowest states of the water, otherwise the wheel must stop at such times.

On the Manner of framing Water-wheels.—The weight of every wheel must be supported by its axis, which therefore demands the first consideration. If the axis is to be of wood it should be made of a tree of hard and durable wood, of a length and size proportioned to the size and weight of the wheel; into each end a gudgeon or centre should be fixed for the wheel to turn upon. There are two methods of fixing the gudgeon into a wooden axis; one is, by forming the gudgeon with a cross, which is let into the end of the tree, and fastened by screws, and the wood is compressed round the cross by two or three iron hoops, fitted on the end of the tree and wedged; this is explained in the article *MILL-Work*. The other method is, to make a strong iron box in a piece with the gudgeon, into which box the end of the tree is received and secured by wedges. The box being of an octagon shape, and the wood being cut to the same figure, it cannot slip round within the box.

Of late years it has been usual to make the great axis of water-wheels of cast-iron, which is a very good plan, provided the axis is made of sufficient dimensions. This was first practised by Mr. Smeaton, but he was rather unfortunate, as several of them broke after having been many years in use: he then employed hollow tubes of cast-iron of large dimensions and considerable thickness of metal. Even

now that the strength of cast-iron is better understood, it is not uncommon for the axis of a water-wheel to break, particularly in cold and frosty weather, and for this reason some millwrights use wrought iron, but the hollow tube is so much stronger, as to be very secure from accident.

In an iron axis it is advisable to make the bearings of the axis close to the sides of the water-wheel, and leave the ends of the axis projecting beyond the bearings, in order to attach the cog-wheel, by which the power of the wheel is to be communicated to other machinery. This diminishes the length of the axis between the bearings, and renders it much stronger; wooden axes must have the gudgeons at the extreme ends.

The next point to be considered is, the best means of affixing the arms of the wheel firmly to the axis. If the arms are of wood, and the axis also, the most obvious plan is to mortise the arms into the axis; but this is the worst method that can be adopted, because the axis is much weakened, and the water being admitted into the centre of the tree causes it soon to decay, nor can an arm be easily replaced without taking all the wheel to pieces.

A better way is to use eight timbers for the arms, and put them together so as to intersect each other at right angles, (as is shewn in *fig. 7. Plate I.*) leaving a square opening in the centre for the reception of the axis, which is made up to a square by adding pieces of wood to it, and the wheel is fastened on by wedges. The only objection to this is, that the arms are weakened by intersecting each other, and they support the circular rim of the wheel in unequal segments.

In Mr. Buchanan's water-wheel, which we have before described in *figs. 4 and 5, Plate I. Water-wheels*, is a particular construction of the arms formed by thin planks of wood. He states that this plan is applicable to any kind of water-wheel; and since 1790, when he first constructed a wheel with arms on that principle, a considerable number of large wheels have been erected in Scotland on the same plan. It is evident that arms, such as are commonly fixed in mortises in the axis, are weakest in one direction, and that commonly in the direction of the strain. To remedy this defect the feather-pieces FF are applied all round, having their broadest ends towards the centre of the wheel, and being at right angles to the breadth of the principal arms. In order to unite them strongly to the principal arms, and connect the whole more firmly together, a ring of iron, R, is applied on each side; blocks of wood being put in the vacant spaces between, and the keys or wedges, K K, bind the whole close to the axis.

The very best method of uniting the arms to the axis is to have a cast-iron centre-piece, or strong hoop, to fit on the wooden axis with a broad projecting flanch round it, against the flat surface of which the arms of the wheel are applied, and the intervals between them filled up by wooden blocks or wedges; the arms and blocks are firmly bound to the iron flanch by iron rings applied to the arms on the opposite side to the flanch, with screw bolts to go through the whole. This same plan is applicable to an iron axis, and will be more clearly understood by a reference to the article *MILL*, and *Plate XXXIV. Mechanics*; but it is there described that the broad circular flanch to screw the arms against, is cast in the same piece with the axis. This was Mr. Smeaton's original plan, but the flanch should be made in a separate piece, and fastened on the axis with wedges; for if cast in the same piece, the contraction of the metal contained in the flanch when cooling, renders the metal of the axis spongy at the part where it joins to the flanch, and causes them to break at that part. Sometimes the cast-iron centre-piece is made with a distinct

distinct cell to receive each arm, and they are fastened into the cells by wedges and screw-bolts, but a flat flanch with the intervals filled up by blocks is more simple and secure. Modern wheels are very frequently made with cast-iron arms, which in this case are attached to the axis by a similar centre-piece.

The circular rims of water-wheels are commonly made of wood, put together in two or three thickneses, the joinings of one ring not coinciding with those of the other, and 8 or 10 segments in each thicknes, according to the size of the wheel; the thickneses are united together by rivets. The arms are attached to the ring by notching them in, and securing them by bolts. Cast-iron rings are now generally used, and with great advantage, because the necessary mortises can be made in iron, without weakening the ring; but the strength of a wooden ring is greatly impaired by the mortises through it.

The number of rings in a wheel depend upon its breadth; when the wheel is four feet wide, two rings will support the float-boards or buckets, but the rings should not be more than five feet asunder, or the floats may bend and yield; for want of a sufficient support each ring is framed with its set of arms, so that every one derives its strength from the axis. When a wheel is of great breadth, the whole will be very much strengthened, by applying oblique braces, extending from the centre-pieces of the outside rings to the circumference of the middle ring, by firmly attaching these oblique braces to the arms of all the rings which they intercept; they form truss-frames which prevent the wheel and the axis from bending by its weight: this is particularly useful in wide overshot wheels.

In breast and undershot wheels the float-boards are nailed to pieces of wood called starts, which are fixed into the mortises in the rings, and project outwards for that purpose.

In overshot-wheels, the rings of the wheels are covered by boards laid parallel to the axis, well jointed together, and spiked down to the rings like the boards of a floor to the joists. This boarding forms a close cylinder, which is called the sole of the wheel, and is the foundation for the buckets. When the rings of the wheel are of iron, holes are left in the castings in the edge of the rings, at regular distances round the circumference, and these are filled up with plugs of wood, into which the nails can be driven to fasten on the boarding of the sole. The sole of the wheel is sometimes made of iron plates rivetted together, and rivetted also to the rings of the wheel.

At the ends of the sole-boards, two circular rings of wood or iron, called shrouds, are fitted on perpendicularly to the sole to form the ends of the buckets; and it is usual, if the wheel is wide, to apply a shrouding over each ring of the wheel, and then the buckets are divided into lengths of about four or five feet. In the flat surfaces of the shroudings, grooves are made for the reception of the ends of the bucket-boards. It is usual to make the first board, which is in the direction of a radius, of wood, and the outside one is generally made of iron plate; but sometimes the whole are made of plate iron, and both parts of the buckets are then bent up out of one piece, and the ends of the plate; and also that part of the edge which is to apply to the sole, is turned square to lie flat against the sole and the shrouding, so that rivets and nails may unite all together, and make water-tight joints.

When the shrouding is of cast-iron, it is made to serve instead of the rings of the wheel, because it has sufficient strength to serve both purposes: the arms of the wheel are in this case applied flat against the ring of shrouding, and bolted to it.

The breast-wheel, *fig. 3. Plate II. Water-wheels*, at Messrs. Strutt's works, which we have already noticed, is deserving of further notice from the manner of putting it together. The rings of the wheel are made of cast-iron, and the float-boards are included between the rings in the manner of an overshot wheel, but the arms are only of wrought iron, being made of small round iron rods, which are very light, and have little strength to resist bending; but as they are all tied in from the centre, the ring cannot deviate from its true circular figure, and to sustain the wheel sideways, oblique bars are extended from the centre-pieces at each end of the axis, and are united to the circular ring in the middle of its breadth, which is 15 feet. We have seen two overshot-wheels of 24 feet diameter, and 9 feet broad, made in the same way. It is plain that in this construction the axis of the wheel can do no office but to support the weight of the wheel; for though these arms are sufficiently strong for that purpose, they can have little strength by way of levers to transmit the force of the circular motion of the rim of the wheel to the axis; but the power is transmitted in a better way than from the axis, *viz.* by a ring of cogs screwed to the circular rim of the wheel, and working in a pinion which conveys the motion to the mill. There is another similar ring of cogs at the other side of the wheel, which works into a pinion fixed on the same shaft, by this means nearly all the strain is taken from the axis of the water-wheel; for the pinion is placed on the descending side of the wheel, so that the weight of the water acting on the float-boards is immediately transmitted to the pinions by the strength of the rings of the wheel.

This method of transmitting the power is also applied to other wheels than those which are made with slight arms like the above; the ring of cogs is sometimes placed in the middle of the breadth of the wheel, and then acts upon one pinion, but it is much better to place it at one side or both sides, if the wheel is very broad, because the circle of the teeth may then be made rather less than the diameter of the rings of the wheel, and the side of the ring being closely fitted to the stone-work of the race, the water may be excluded from the cogs.

It is obvious that of the various constructions of water-wheels, that is the strongest which communicates its motion by means of a ring of cogs immediately attached to its rim, where the power of the water is also applied, the least possible strain being thus thrown on its arms and axis.

The only objection to this plan is, that as the teeth of the cog-wheel are in most cases constantly wet, which prevents the grease from adhering, the usual mode of occasionally greasing the cogs is of little or no use, and the dirt in the water grinds away the teeth; or, were the water even free from dirt, there would be much unnecessary friction and waste of power.

Greasing Machine for the Cog-Wheel of a Water-Wheel.—Mr. Buchanan mentions two water-wheels of this kind, in which the rings of the teeth were wearing very fast, and knowing the trouble and expence of renewing them, he was solicitous to discover some means of rendering them more durable. The only way which presented itself was by some contrivance to keep them well greased.

This he did by a machine shewn in *fig. 8. Plate I. Water-wheels*; it is nothing more than a kind of pinion, with one or more of its teeth made hollow to contain the greasy substance, and the metal plate of which the hollow cog is composed is perforated with small holes, for exuding the grease through those parts which come in contact with the teeth of the wheel.

Fig. 8. is a section of the greasing machine; A B represents part of the ring of teeth on the circumference of the

water-wheel. The greasing-pinion which works in these teeth is mounted on an axis, as is clearly shewn.

N O a retarding lever, of which N is the fulcrum, and O a weight to make it press on the axis of the greasing-pinion, so as to cause a resistance, and make the cogs of the wheel press forcibly on the cogs of the pinion.

G H I K, the hollow teeth for containing the grease; they are made of copper-plate or iron; and to make the perforated sides of the greasing leaves come in close contact with the face of the teeth of the wheel, the lever N O, with a small weight on it, acts on a pulley fixed on the axle of the pinion, and serves to retain it.

E F, &c. the solid teeth of the pinion, made of wood; there are sliders which open for admitting the grease into the hollow teeth at their ends.

The number of leaves in the greaser should be such, that those containing the grease shall apply themselves in the course of several revolutions of the wheel to each of its teeth. Mr. Buchanan found a greaser of 12 leaves, 4 of which contained grease, had this effect upon a wheel of 304 teeth; and one of 13 leaves, with one tooth only filled with grease, served a wheel of 168 teeth.

It is best to use a mixture of tallow, oil, and black lead for greasing, made of a consistency to feed regularly, and freshened about twice in a week.

Construction of a Breast-Wheel of very great Width.—At Messrs. Strutt's works is a very powerful breast-wheel, made of the extraordinary width of 40 feet, and it deserves our notice from the manner of framing it together; its diameter is only 12½ feet, and it is made without any axis, or rather the axis is hollow, and so large that the float-boards are fixed immediately upon it. It is made like a very long cask, 48 feet long, composed of 32 staves of six inches thickness, bound together by hoops like an ordinary cask; it is five feet in diameter at one end and six feet at the other, and in the middle 7 feet 2 inches; the small end is made up solid for three feet in length, and the gudgeon is fixed in this solid part; the larger end is solid for four feet from the end, and on this part the large cog-wheel is fixed to communicate the motion to the mill; it is 14 feet diameter, and has 120 cogs, whilst the water-wheel is only 12½ feet diameter to the outside of the floats. The floats are supported by 10 circular rings, which are fixed on the outside of the axis or cask, at four feet distance from each other, and the float-boards are fixed between these rings, 24 floats being arranged in each circle; but the floats in the different spaces are not made to line with each other, because if the water was to strike upon the whole length of 40 feet of float-board at once, it would give a sensible shock to the water-wheel, and work the mill irregularly; hence the floats between all the different rings are placed opposite to the intervals between the floats in the adjoining spaces, by which means the water acts on the floats in rapid succession, so that the stroke upon any one float is imperceptible.

The float-boards are not made to touch the central-barrel or axis within two inches, in order to leave space for the air to escape. The float-boards in the middle of the wheel are 2 feet 4 inches wide, and at the ends are wider. This wheel has two shuttles, one above the other, like the breast-wheel before described in *fig. 3*, and the same dimensions; for the wheel is placed in the same mill, but is adapted to work when the tail-water rises in time of floods to such a height as to prevent the other wheel from working.

A very large overshot Wheel.—The largest overshot water-wheel of which we have heard, is that at Mr. Crawshaw's iron-works at Cyfarthfa, near Merthyr Tydvil, in South Wales: it is used to blow air into three of the large blast

furnaces for smelting iron; the water-wheel is fifty feet in diameter and six feet wide: it is chiefly made of cast iron, and has 156 buckets. The axis is a hollow tube, and is strengthened by twenty-four pieces of timber applied round it. On each end of the axis is a cog-wheel of twenty-three feet diameter, which turns a pinion. On the axis of these are two cranks, and a fly-wheel twenty-two feet diameter, and twelve tons weight; each of the cranks gives motion to a lever, like that of a large steam-engine, and works the piston of a blowing cylinder or air-pump 52½ inches in diameter, and five feet stroke, which blows air into the furnace, both when the piston goes up and down. The work on the other side being the same, it actuates in the whole four of these double cylinders; the wheel makes about two and a half turns *per minute*, and each cylinder makes ten strokes. It is called *Æolus*, and was built in 1800 under the direction of Mr. Watkin George.

At Aherdare, in South Wales, is an immense double water-wheel, consisting of two wheels of forty feet in diameter, placed one above the other like the figure 8, (see our article *CANAL*;) the water from the upper one actuating the lower one, and both being connected together by cog-wheels on their respective rings. We understand this machine has not answered, and we only mention it as an attempt to occupy a fall of water of eighty feet; in such cases, the *Pressure-engine*, described under that article, is a better method, particularly if the work will admit of a reciprocating motion.

Chain of Buckets.—This is applicable in many situations where there is a considerable fall of water. This sketch was taken from one in Scotland used to give motion to a thrashing-mill; the *fig. 6. Plate I.* is so obvious as to need little explanation. The buckets C, D, G, H, &c. must be connected by several chains to avoid the danger of breaking, and united into an endless chain, which is extended over two wheels A and B, the upper one being the axis which is to communicate motion to the mill-work; E is the spout to supply the water. The principal advantage of this plan is, that no water is lost by running out of the buckets before they arrive at the lowest part, as is the case with the wheel. Another is, that the buckets being suspended over the wheel A of small diameter, it may be made to revolve more quickly than a wheel of large diameter, and without increasing the velocity of the descending buckets beyond what is proper for them. This saves wheel-work when the machine is to be employed, as in a thrashing machine to produce a rapid motion. On the other hand, the friction of the chain in folding over the wheel at the top, and seizing its cogs, will be very considerable; these cogs must enter the spaces in the open links between the buckets, to prevent the chain slipping upon the upper wheel. We think this machine might be much improved by contriving it so, that the chain would pass through the centre of gravity of each bucket, whereas in the present form, the weight of each bucket tends to give the chain an extra bend.

The *Chain-Pump reversed* has been proposed as a substitute for a water-wheel when the fall is very great, and we think it would answer the purpose with some chance of success. It would have an advantage over the chain-pump when employed for raising water, in the facility of applying cup leathers to the pistons on the chain, in the same way as other pumps, which leathers expand themselves to the inside of the barrel, and are kept perfectly tight by the pressure of the water. In the chain-pump such leathers cannot be employed, because the edges of the leather-cups would turn down and stop the motion, when the cups were drawn upwards into the barrel. It is the defective mode of leathering the pistons of the chain-pump which occasions its great friction. In the motion of a machine of this kind

WATER.

the pistons would descend into the barrel, and might therefore be leathered with cups like other pumps, so as to be quite tight without immoderate friction. This machine was proposed by a Mr. Cooper in 1784, who obtained a patent for it, and Dr. Robison has again proposed it with recommendation.

Mechanism for equalizing the Motion of Water-Wheels.—When a part of the machinery of a mill is suddenly detached from the first mover, or suddenly connected with it, the load of the machine is either increased or diminished; and the moving power remaining the same, an alteration in the velocity of the whole will take place; it will move faster or slower. Every machine has a certain velocity, at which it will work with greater advantage than at any other speed; hence the change of velocity arising from the above cause, is in all cases a disadvantage, and in delicate operations exceedingly hurtful. In the case of a cotton mill, for instance, which is calculated to move the spindles at a certain rate, if from any cause the velocity is much increased, a loss of work immediately takes place, and an increase of waste from the breaking of the threads, &c.; on the other hand, there must be an evident loss from the machinery moving too slow. In steam-engines this evil is remedied by a contrivance called a governor, which we have already described in our article *STEAM-Engine*.

Governors are sometimes applied to water-wheels, and made on various constructions. Smith-bellows have been applied to that use, the upper board rising and falling on any augmentation or diminution of the velocity of the lower board, which received its motion from the mill, and forced air into the space beneath the upper board; from this space the air was permitted to escape by a pipe with a cock. If the lower board worked faster than the air could escape, the upper board would rise, but if it moved slower, then the board would sink; and this rising and falling was applied to regulate the shuttle of the water-wheel, not by the force of the bellows alone, but the bellows were made to throw the wheel-work of the mill into action, either to raise or lower the shuttle.

Of late years a new kind of water-wheel governor has been introduced, the principles of which are nearly the same as the governor of a steam-engine. It has a revolving pendulum, which receives its motion from the mill, and in proportion as the machinery moves faster or slower, the centrifugal force acts with greater or less force upon the balls of the governor, making them approach to, or recede from, the perpendicular axis. This raises or depresses an iron cross, which slides upon the perpendicular axis of the revolving pendulum, and by acting on a lever, is made to engage the sluice with a train of wheel-work, which is kept in constant motion by the power of the water-wheel. When this train is connected with the sluice, it operates upon it so as to enlarge or lessen the passage of the water to the water-wheel, and by augmenting or lessening the quantity of water falling on the wheel, increases or diminishes its speed.

This sluice is made on the principle of the throttle-valve of steam-engines. In order that it may be moved by a small power, it is poised on an axis of motion passing through the middle of the sluice. When it is turned edgewise to the stream of water, it makes no obstruction; but if it is turned perpendicularly, it closes the passage of water, or by placing it more or less obliquely, it alters the area of the passage for the water.

The axis on which the sluice turns, if horizontal, should be one-third of the height of the sluice from the bottom, in order that the pressure of the water above the centre may balance that below.

So long as the machinery is moving at a proper velocity, this wheel-work of the sluice apparatus is not connected with the sluice, and it remains at rest. But if the mill goes too slow, the cross is depressed, and striking the lever in an opposite direction, connects the sluice with a different part or train of wheel-work, which has a motion in a contrary direction to the former, and so produces a contrary effect on the sluice.

The train of wheel-work is so calculated, as to reduce the action on the sluice to a very slow motion, and it is found, from experience, that this is necessary. Where the area of the aperture is too suddenly changed, the effect on the water-wheel would be too violent. See a more complete description of this contrivance in Vol. XXIII. *MILL-Work*.

On the Construction of the Wheel-race and Water-course.—The wheel-race should always be built in a substantial manner with masonry, and if the stones are set in Roman cement, it will be much better than common mortar. The earth behind the masonry should be very solid, and if it is not naturally so, it should be very hard rammed and puddled, to prevent percolation of the water. This applies more particularly to breast-wheels, in which the water of the dam or reservoir is usually immediately behind the wall or breast in which the wheel works, a sloping apron of earth being laid from the wall in the dam to prevent the water leaking. The wall of the breast should have pile planking (see *CANAL*) driven beneath, to prevent the water from getting beneath, because that might blow up the foundation of the race. The stones of the race are hewn to a mould, and laid in their places with great care; but afterwards when the side walls are finished, and the axis of the wheel placed in its bearings, a gauge is attached to it and swept round in the curve, and by this the breast is dressed smooth, and hewn to an exact arch of a circle: the side walls in like manner are hewn flat and true at the place where the float-boards are to work. It is usual to make the space between the side walls two inches narrower at each side, in the circular part where the floats act, than in the other parts.

In some old mills the breast is made of wood planking, but this method has so little durability that it cannot be recommended. In modern mills, the breast is lined with a cast-iron plate, but we do not approve of this, because it is next to impossible to prevent some small leakage of water through the masonry, and this water being confined behind the iron breast cannot escape, but its hydrostatic pressure to force up the iron is enormous; and if the water can ever insinuate itself behind, the whole surface of the plate rarely fails to break it, if not to blow it up altogether. This is best guarded against by making deep ribs projecting from the back of the plate, and bedding them with great care in the masonry; these not only strengthen the plate, but also cut off the communication of the water, so that it cannot act upon larger surfaces at once, than the strength and weight of the plate can resist. Stone is undoubtedly the best material for a breast. In overshot-wheels the loss of water, by running out of the buckets as they approach the bottom of the wheel, may be considerably diminished by accurately forming a sweep, or casing round the lower portion of the wheel, so as to prevent the immediate escape of the water, and causing it to act in the manner of a breast-wheel, which has been already described. While this improvement remains in good condition, and the wheel works truly, it produces a very sensible effect; but it is frequently objected to, because a stick or a stone falling into the wheel would be liable to tear off part of its shrouding, and damage the buckets; and again, a hard frost frequently binds all fast, and totally prevents the possibility of working during its continuance;

nuance; but we do not think the latter a great objection, for the water is not more liable to freeze there than in the buckets or on the shuttle, and may be prevented by the same means, *viz.* by keeping the wheel always in motion; a very small stream of water left running all night will be sufficient. Mr. Smeaton always used such sweeps, and with very good effect; it is certainly preferable to any intricate work in the form of the buckets.

On setting out Water-courses and Dams.—The most ancient mills were under-shot-wheels placed in the current of an open river, the building containing the mill being set upon piles in the river. It would soon be observed that the power of the mill would be greatly increased, if all the water of the river was concentrated to the wheel, by making an obstruction across the river which penned up the water to a required height; and also to form a pool or reservoir of water. A sluice or shuttle would then become necessary to regulate the admission of water to the wheel, and other sluices would be necessary to allow the water to escape in times of floods; for though in ordinary times the water would run over the top of the obstruction or dam, yet a very great body of water running over might carry away the whole work, by washing away the earth at the foot of the dam, and then overturning it into the excavation. This is an accident which frequently happens to mills so situated, and the danger is so obvious, that most water-mills are now removed to the side of the river, and a channel is dug from the river to the mill to supply it with water, and another to return the water from the mill to the river. The difference of level between these two channels is the fall of water to work the mill, and this is kept up by means of a weir or dam entirely across the river; but the water can run freely over this dam in case of floods, without at all affecting the mill, because the entrance to the channel of supply is regulated by sluices and side walls.

The dam should be erected across the river at a broad part, where it will pen up the water so as to form a large pond or reservoir, which is called the mill-pond or dam-head. This reservoir is useful to gather the water which comes down the river in the night, and reserve it for the next day's consumption; or for such mills as do not work incessantly, but which require more water, when they do work, than the ordinary stream of the river can supply in the same time. The larger the surface of the pond is, the more efficient it will be; but depth will not compensate for the want of surface, because as the surface sinks, when the water is drawn off, the fall or descent of the water, and consequently the power of the water, diminishes.

The dam for a large river should be constructed with the utmost solidity; wood framing is very commonly used, but masonry is preferable. Great care must be taken, by driving pile planking under the dam, to intercept all leakage of the water beneath the ground under the dam, as that loosens the earth, and destroys the foundation imperceptibly; when a violent flood may overthrow the whole. It is a common practice to place the dam obliquely across the river, with a view of obtaining a greater length of wall for the water to run over, and consequently prevent its rising to so great a height, in order to give vent to the water of a flood. But this is very objectionable, because the current of water constantly running over the dam, always acts upon the shore or bank of the river at one point, and will in time wear it away, if not prevented by expensive works. This difficulty is obviated, by making the dam in two lengths which meet in an angle \triangleright , the vertex pointing up the stream. In this way the currents of water, coming from the two opposite parts of the dam, strike together, and

spend their force upon each other, without injuring any part. A still better form is a segment of a circle, which has the additional advantage of strength, because if the abutments at the banks of the river are firm, the whole dam becomes like the arch of a bridge laid down horizontally. This was the form generally used by Mr. Smeaton.

The foot of the dam where the water runs down should be a regular slope, with a curve, so as to lead the water down regularly; and this part should be evenly paved with stone, or planked, to prevent the water from tearing it up, when it moves with a great velocity.

When the fall is considerable, it may be divided into more than one dam; and if the lower dam is made to pen the water upon the foot of the higher dam, then the water running over the higher dam will strike into the water, and lose its force. There is nothing can so soon exhaust the force of rapid currents of water as to fall into other water, because its mechanical force is expended in changing the figure of the water (see *circular weir* in our article CANAL); but when it falls upon stone or wood, its force is not taken away, but only reflected to some other part of the channel, and may be made to act upon such a great extent of surface as to do no very striking injury at any one time, but by degrees it wears away the banks, and requires constant repairs: for it is demonstrable that, as much of the force of the water as is not carried away by the rapid motion with which it flows, after passing the dam, must be expended either in changing the figure of the water, or in washing away the banks, or in the friction of the water running over the bottom.

The cotton-works of Messrs. Strutt at Belper, in Derbyshire, are on a large scale, and the most complete we have ever seen, in their dams and water-works. The mills are turned by the water of the river Derwent, which is very subject to floods. The great weir is a semicircle, built of very substantial masonry, and provided with a pool of water below it, into which the water falls. On one side of the weir are three sluices, each 20 feet wide, which are drawn up in floods, and allow the water to pass sideways into the same pool; and on the opposite side is another such sluice, 22 feet wide. The water is retained in the lower pool by some obstruction which it experiences in running beneath the arches of a bridge; but the principal fall of the water is broken by falling into the water of the pool, beneath the great semicircular weir.

The water which is drawn off from the mill-dam above the weir passes through three sluices, 20 feet wide each, and is then distributed by different channels to the mills, which are situated at the side of the river, and quite secure from all floods. There are six large water-wheels; one of them, which is 40 feet in breadth, we have mentioned, from the ingenuity of its construction; and another which is made in two breadths, of 15 feet each, we have also described. They are all breast-wheels. The iron-works of Messrs. Walker at Rotherham, in Yorkshire, are very good specimens of water-works; as also the Carron works in Scotland.

The largest works for overshot-mills are in Russia, at Colpino, near St. Petersburg, on the river Neva. They were erected principally under the direction of Mr. Gafcoigne of the Carron works in Scotland, and have been greatly improved by the present director, who is an engineer of his school. An immense dam of granite is built across the river to pen up the water, until it makes a large reservoir. The waste and flood waters do not run over this dam, but are conducted out of the reservoir by a semicircular branch of the river, and run over a great weir to join the original course of the river below the works. The mills

mills are situated in the valley below the great dam, the water being conveyed to the wheels by channels coming through the dam, and conveyed away into a large tail basin, which is the original course of the river. The wheels, which are very numerous, are all 22 feet diameter. They are placed in several different mills, for rolling and forging iron and copper, boring guns, making anchors, &c. These mills are arranged on the sides of the tail basin, which is navigable to bring the boats up to them. There are also two large saw-mills at the end of the semicircular channel.

These works are very complete, owing to the excellent execution of the dam and water-works; but it is not a good plan to place the mills beneath the dam, because if it should fail, or the water pour over it by an extraordinary flood, the mills and buildings below would be in danger of being carried away; whereas, on the other construction, the mills, being placed at a distance from the river, are perfectly safe, and would not be injured if the dam should be wholly carried away. This is not a fault imputable to the gentlemen we have mentioned, as the foundations of these works were commenced in the time of Peter the Great, and too far advanced to admit of altering the plan radically, when the empress Catherine invited Mr. Gafcoigne to Russia, in 1786, to enlarge them to their present magnitude.

On the Distribution of the different Falls of Water in Rivers.—In erecting a mill, care must be taken to place it so that it shall not be impeded by flood-waters, except when they rise to excess. When the water below will not run off freely, but stands penned up in the wheel-race, so that the wheel must work or row in it, the wheel is said to be tailed, or to be in back water or tail water.

Upon most rivers in this country all the falls of water are fully occupied, and at every mill there is a weir, which pens up the water as high as the mill above can suffer it to stand without inconvenience. Each miller is anxious to obtain the greatest possible fall, and he can at any time augment the fall, by raising the surface of his weir; but as this may produce an inconvenience to the mill above, in preventing the water from running freely away from its wheel, it is a constant source of dispute and litigation. A mill may be subjected to tail-water by the concurrence of so many circumstances, that it is frequently very difficult to know where to seek the best remedy, whether the miller ought to raise his wheel higher and diminish his own fall, or insist upon a diminution of his neighbour's below him by lowering his weir.

The following rule is that which Mr. Smeaton constantly followed, in placing successive dams upon rivers, whether for the erection of mills or for navigation. In flat countries, where the falls of water are small, and consequently tail or back water is most troublesome, those dams must be so built, that no one shall pen the water into the wheel-race of the mill next above it, when the river is in its ordinary summer's state. The same rule we have found generally subsisting in ancient mills.

This rule is founded upon reason; for if the erection of a dam does not affect the mill above by tail-water, in dry seasons, when water is the most scarce, it can do no material injury at any other time. Every mill that is well and properly constructed will clear itself of a considerable depth of tail-water, provided it has at the time an increase of the height of water in the mill-dam or head, and an unlimited quantity of water to draw upon the wheel; for if floods produce tail-water, they also increase the head water, and afford a superior quantity to be expended. This is the proper means by which a number of mills on the same river are to be cleared of back-water, as far as is consistent with the mutual enjoy-

ment of their several falls of water. This alone is a very sufficient security against any one being injured. Common breast-mills will bear two feet of tail-water, when there is an increase of head, and plenty of water to be drawn upon the wheel, without prejudice to their performance; but mills well constructed, with slow moving wheels, will bear three and even four feet and upwards of tail-water. Mr. Smeaton mentions having seen an instance of six feet; and it is a common thing in level countries, where tail-water is most annoying, to lay the wheels from six to twelve inches below the water's level of the pond below, in order to increase the fall of water; and, if judiciously applied, is attended with good effect, as it increases the diameter of the wheel, and though it must always work in that depth of tail-water, it will perform full as well, because the water ought always to run off from the bottom of the wheel, in the same direction as the wheel turns.

The law respecting mill property is by no means settled, but is greatly influenced by the custom of the mills upon any river or in any district; some few points however are established. Every one has a right to that fall which the water has, in running through his own grounds, and may make what use he pleases of the descent of the water, provided that he does not divert the water, at the tail of his estate, into any other channel, or that he does not pen up the water higher than the level at which it has always entered into his land; he has also a right to insist that the miller below shall let the water depart from his grounds, at the same level at which it has always been used to do. The knowledge of this is very necessary, because a miller very frequently finds himself seriously injured, when he is not entitled to any redress. It scarcely ever happens that any considerable improvements or alteration in mills can be made, without producing disputes among the parties interested. Suppose, for instance, that there are two ancient mills upon a river, with an unoccupied descent in running over the lands between them, the proprietor of this land, by deepening the channel and erecting a weir, may bring all the fall into one place and erect a mill, without infringing the conditions we have laid down; but still the miller below him may be considerably injured: for in the original state the river, in running down with a regular and easy slope, from the upper mill to the lower, held a great quantity of water, which was a *corps de reserve* for the miller below, and tended to regulate his supply. If the upper mill stopped working, the water contained in the river would still run down to him, and so long as that lasted he could continue to work, perhaps until the upper mill began to work again, and thus he would suffer no interruption. The erection of an intermediate mill cuts off this resource, and he will be obliged to stop working very soon after the new mill stops working; and further, he is obliged to work when the new mill is at work, or else the water poured down will run over his mill-dam and be wasted; but, in the former instance, the water would have come down less suddenly, and he might be able to set to work before the whole of the water had escaped over his weir.

In such a case the lower miller may be inclined to appeal to the law, but he will find that he has no right to prevent his neighbour above from using the water in the same manner as he does himself, and if he finds any alteration in his own mill, it is for want of a capacious mill-pond to reserve the water. In the original state the channel of the river in his neighbour's ground above served him in some measure as a mill-dam, by retaining the water for a given time, though it would not retain it permanently. The advantage of this he had enjoyed for a long time, when it was no inconvenience to his neighbour, but had acquired no right to demand

which will be exerted upon each stone of the masonry to thrust it outwards.

Depth beneath the Surface in Feet.	Pressure on each St. ne, or on every Square Foot, in P. unds.
1	62.5
2	125
3	187.5
4	250
5	312.5
6	375
7	437.5
8	500
9	562.5
10	625

The length and width of the tank does not influence the pressure upon each stone; because, following our first proposition, we are only to regard the magnitude of the plane against which the water acts, and the depth at which it is situated beneath the surface. But in all cases when the plain is not horizontal, the depth of the water will be greater upon some parts of the plane than upon others. The depths must therefore be taken from the *centre of pressure* of the plane; see that article in Vol. VII.

The knowledge of the centre of pressure is required, in order to apply this calculation to wooden vessels, such as the large backs used by brewers; or to find the pressure against the gates of a sluice or lock, or in any other case where the wood planks, or the stones of the masonry are so united together into one mass, that the whole side of the vessel must be removed together. If the plane against which the water acts rises up as high as the surface of the water, and is of a rectangular figure; that is, if all its horizontal dimensions, whether taken at the bottom of the vessel or at the top, are equal, then the centre of pressure is situated at $\frac{2}{3}$ ds of the greatest depth beneath the surface.

Example.—A wooden vat is 18 feet long, and contains water 6 feet deep; required the force which the water exerts against the side of the vat to force it outwards. Two-thirds of 6 feet is 4 feet, which is the depth of the centre of pressure: $4 \times 62.5 = 250$ lbs. is the mean pressure upon each square foot of the plane, 18 feet long \times 6 feet deep = 108 square feet of area \times 250 lbs. 27,000 lbs., which is the force exerted against the side of the vessel, and must be resisted by the strength of the materials.

On the Means of measuring or gauging the Quantity of running Water.—The ancients seem to have had no other measure of running water than that uncertain and fallacious one, which depended wholly on the perpendicular section of a stream, without considering the velocity of the motion. The first who opened a way to the truth was Benedict Castelli, an Italian, and friend of Galileo. He first shewed that the quantity of water, flowing through a given section of a stream, is proportional to the celerity with which the water is carried through that section. This observation engaged philosophers to study the doctrine of the motion of fluids with much diligence, and after Castelli's time there was scarcely any mathematicians who did not endeavour to add something thereto, either by experiments or by reasoning and argument.

But few of them, until the illustrious sir Isaac Newton, had any success, because of the exceeding difficulty of the subject.

Those who studied the theory laid down such theorems as were found to be false, when brought to the test of experiments, and those who laboured in making experiments frequently omitted to observe some minute circumstances, the

importance of which they had not yet perceived. Hence they differed greatly from one another, and almost all of them erred from the real measure.

The theory of hydraulics has never been carried to a very high degree of perfection upon mathematical foundation alone, nor has it hitherto, even with the assistance of experiment, been rendered of much practical utility. Newton began the investigation of the motions of fluids on true principles. Daniel Bernouilli added much valuable matter to Newton's propositions, both from calculation and experiment. D'Alembert, and many later authors, have exercised their analytical talents in inquiries of a similar nature.

Dr. Robison observes that these, and other mathematicians of the first order, seem to have contented themselves with such views as allowed them to entertain themselves with elegant applications of calculus. They rarely had any opportunity of doing more, for want of a knowledge of facts, but they have made excellent use of the few which have been given them.

It requires much labour, great variety of opportunities, and great expence, to learn the multiplicity of things which are combined, even in the simplest cases of water in motion. These advantages seldom fall to the lot of a mathematician, and he is without blame when he enjoys the pleasures within his reach, and cultivates the science of geometry in its most abstracted form. Here he makes a progress which is the boast of human reason, being almost insured from every error, by the intellectual simplicity of his subject. But were we to turn our attention to material objects, we know neither the size and shape of the elementary particles of water, nor the laws which nature has prescribed for their action. We cannot, therefore, presume to foresee their effects, calculate their exertions, or direct their actions, with any reasonable expectations of certainty.

A different and more practical mode of attaining hydraulic knowledge, has been attempted by a distinct class of investigators. These have begun from experiment alone, and have laboriously deduced, from very ample observations of the actual results of various particular cases, the general laws by which the phenomena appear to be regulated, or at least the formulas by which the effect of new combinations may be predicted. But it must be confessed, that these formulas, however accurate, are almost too intricate to be retained in the memory, or to be very easily applied to calculations from particular data.

There are two gentlemen whose labours in this respect deserve very particular notice, professor Michelotti, at Turin, and abbé Bossut, at Paris. The first made a prodigious number of experiments, both on the motion of water through pipes and in open canals. The experiments of Bossut are also of both kinds, and though on a much smaller scale than those of Michelotti, they seem to deserve equal confidence. The chevalier de Buat, who has taken up this matter where the abbé Bossut left it, has prosecuted his experiments with great assiduity and singular success.

Mr. Eytelwein, a gentleman honoured with several employments and titles relative to the public architecture of the Prussian dominions, made a translation of Buat's works into German, with important additions of his own; and he also published "Handbuch der Mechanik und der Hydraulik," Berlin, 1801. In this compendium of mechanics and hydraulics, he has collected the principal facts that have been ascertained, as well by his own experiments as by those of former authors, especially such as are the most capable of practical application. He appears to have done this in so judicious a manner, as to make his book a most valuable abstract

abstract of every thing that can be deduced from theory, respecting natural and artificial hydraulics. The elegant conciseness of his manner deserves so much the more praise, as his countrymen too often make a merit of prolixity.

In our article DISCHARGE, we have given the general principles of the motion of spouting fluids; and under RIVER the theory of water running in rivers. The object of the present article will be to lay down such rules as may be immediately applicable to the use of the engineer.

In all cases of gauging streams, the quantity which flows, in any given time, is obtained by measuring the area of the aperture, or channel, through which the water flows, and finding the velocity with which the water moves through that aperture. To find the area of the aperture is a simple operation of mensuration, but to ascertain the velocity is not so easy. There are two different methods of determining the velocity. The first is, by observing the rate of motion of the surface, either by means of small light bodies thrown into the stream, or by employing instruments adapted to measure the rate at which the stream moves. This method is only applicable in cases of open canals and rivers, where the water flows with a slow motion. The other method is more general, and is applicable to the greatest velocities; because it is derived from calculation, according to the depth of water, or height of column, which urges the flowing water, and occasions its motion.

To measure the Quantity of Water running in a River or Canal. First Method.—Choose a part of the channel where the banks are of a determinate figure, and where they continue of the same breadth and depth for a length of ten, twenty, or thirty feet, the longer the better, and the more regular the banks are, the better the observations will be. Measure the breadth and the depth, or other dimensions which may be necessary, to find the area, or section of the passage, through which the water flows. Take these measures at several different points, and if there is any difference at different places, find the area at each place, and take a mean between them.

Then proceed to find the velocity of the motion, by throwing in a cork, or other light body, and observing, by a stop-watch, or pendulum, what number of seconds it takes to flow through a given length of the channel; for instance, the length of ten, twenty, or fifty feet, which was chosen in the first instance for the experiment, and marked out by stretching two strings, parallel across the river. This trial must be repeated several times, and as the instant when the floating body arrives at the last string, can be very exactly noted, this method admits of considerable exactness. A mean of the different results must be taken for the true velocity.

It is true that this only gives the velocity of the water at the surface, and the water moves with different velocities at different depths, beneath the surface; (instead of a single light body to float upon the surface of the water), we are recommended to employ a cylindrical rod of wood, of a length something less than the depth of the water: this is to be ballasted by a weight at the lower end, so that it will swim just upright in standing water, and with the upper end of the stick about an inch above water. By using this, instead of a single cork, we are supposed to attain the mean velocity of the stream at its different depths, instead of the velocity of the surface.

Instead of a cylinder of wood, three or four apples, strung together by a string, will answer the purpose very well, the lower ones being loaded by putting nails in them till they are rather heavier than water, so that the apples, when put into standing water, will hang in a per-

pendicular line. Gooseberries are very nearly the weight of water, and may be employed singly, to shew its velocity at different depths.

Example.—A canal measured eight feet in width, and four feet in depth, the sides being perpendicular; then the area of the section is thirty-two square feet. It was found, by experiments with three apples, that the current ran through a space of fifteen feet in five seconds, in another experiment six seconds, and in a third four seconds and a half. What is the quantity of water passing through this canal?

The mean of all these is five seconds and one-sixth, during which the water moved fifteen feet. Now as five seconds and one-sixth is to fifteen feet, so is sixty seconds to a hundred and seventy-four feet, which the stream flows in the space of a minute. Then thirty-two square feet (the area), multiplied by 174 feet, gives 5568 cubic feet, which is the quantity of water flowing through the canal every minute.

This is the method recommended by Defaguliers, and if carefully executed, and the trials frequently repeated, is tolerably exact. Several authors have supposed this method might be much improved, by employing some instrument to shew the velocity of the stream by inspection. There are many ingenious inventions for this purpose.

Stream-Measurers.—M. Pitot invented a stream-measurer of a simple construction, to find the velocity of any part of a stream. This instrument is composed of two long tubes of glass open at both ends, and placed in a perpendicular direction in the stream of water: one of these tubes is cylindrical throughout and straight; but the other has its lowest extremity bent nearly at right angles, so as to form a horizontal branch, which gradually enlarges like a funnel, or the mouth of a trumpet; both these tubes are fixed to the side of a triangular prism of wood, with the lengths of the tubes parallel to the length of the prism, and their lower extremities both on the same level; the horizontal branch of the tube is carried through the prism, so that the end of the trumpet-mouth opens in one of the angles of the prism. The upright parts of the tubes stand one beside the other, and are let into grooves in the prism, so as to be tolerably well preserved from accidents. The face of the prism in which these tubes stand, is graduated on the edges close by the sides of them into divisions of inches and lines.

To use this instrument, it is placed perpendicularly in the water in such a manner, that the opening of the trumpet-mouth at the bottom of one of the tubes, shall be completely opposed to the direction of the current, in order that the water may pass freely through the funnel up into the perpendicular tube. Then by observing to what height the water rises in each tube, it will be found to rise higher in the tube with the trumpet-mouth than the other, and the quantity of this difference will be the height due to the velocity of the stream.

It is manifest that the water will rise in the straight cylindrical tube to the same height as the surface of the stream: this is by the hydrostatic pressure. But the water of the current entering by the funnel into the other tube, will be compelled to rise above that surface to some certain height, at which height it will be sustained by the impulse of the moving fluid; that is, the momentum or impulse of the stream will be in equilibrium with the column of water sustained in one tube above the surface of that in the other. In estimating the velocity by means of this instrument, we must have recourse to the following rules: if the height of the column sustained by the stream, or the difference of heights in the two tubes be taken in feet, the velocity of

the stream *per* second in feet will be 6.5 times the square root of the height.

If the height be measured in inches, then the velocity in feet *per* second will be 1.88 times the square root of the height, nearly. It will be easy to put the funnel into the most rapid part of the stream, by moving it about to different places, until the difference of altitude in the two tubes becomes the greatest. In some cases, it will happen that the immersion of the instrument will produce a little eddy in the water, and thus disturb the accuracy of the observation; but keeping the instrument immersed only a few seconds will correct this. The wind also would affect the accuracy of the experiments; it is therefore advisable to make them when there is little or no wind.

By means of this instrument, the velocity of water at various depths in a canal or river may be found with tolerable accuracy, and a mean of the whole drawn. Where great accuracy is not required, the bent tube with the funnel at bottom will alone be sufficient, because the surface of the water will be indicated with tolerable precision, by that part of the prismatic frame for the tube which has been moistened by the immersion.

M. Pitot likewise proposed that a similar instrument should be used instead of a log, to determine the rate at which a ship sails. For this purpose, in the middle of a vessel, or as near as can be to the centre of its oscillations, place two tubes of metal of three or four lines in diameter, one of them being straight, and the other bent at bottom and enlarged into a conical funnel. The lower ends of both are to dip into the water in which the vessel sails, and there will be no evil to apprehend from orifices so minute. Into these metallic tubes, two others are closely fitted at a convenient height for the observations. The water will rise, in the first of these tubes, up to its level on the outside of the ship; and in the second, up to a certain height, which will indicate as above the velocity of the vessel. For the funnel being turned towards the prow of the ship, it will, in consequence of the motion, be affected in like manner, as if it were plunged into the stream of a running water. The actual velocity of the vessel is found by the same rules as that of the current. This method has been re-proposed in this country, without any acknowledgments to M. Pitot. We do not, however, recommend its adoption on board a ship; for, notwithstanding its theoretical ingenuity, it is liable to many sources of error in practice, and would not, it is probable, furnish more accurate measures of a ship's way, than those deduced from the common log.

In the practical use of M. Pitot's instrument, a great difficulty is experienced from the oscillations of the water in the tubes, which it is not easy to prevent, and a mean height of the oscillating water must be taken.

M. Du Buat made trials of the instrument, and found it could not be trusted for any other purposes than to give the ratios of different velocities. He found the instrument was better without the straight tube, and he employed only one tube with its lower end turned horizontally, in the direction of the stream, it was made of tinned plate instead of glass, and sufficiently large to admit a float to shew the height of the water in the tube. Instead of making the end of the tube an open trumpet-mouth, he used to close it by a flat plate, with a small perforation in the centre to admit the water through it, or in some cases several small perforations. In this way, the water will rise in the tube, just the same as if it was open; but the oscillations of the column will be avoided, or greatly diminished.

The hydraulic quadrant has been recommended by several authors, for measuring the velocity of water.

It consists of a small quadrant with a divided arch, and having two threads moving round its centre. One of these is short, and carries a plummet which always hangs in air, and serves to place the quadrant in its true position. The other thread is longer, and carries a weight whose specific gravity is greater than that of water, and which plunges more or less deep in the current as the thread is lengthened. The instrument is held over the water, so that the plummet of the long thread hangs in the water, and the force of the current will remove it from the perpendicular, whilst the angular distance from the other thread, which is a vertical line can be ascertained by the divisions on the arch of the quadrant; the quantity of this deviation from the perpendicular is the measure of the force, and consequently of the velocity of the current. Boffut has shewn, that the force of the current is as the tangent of the angle which one thread makes with the other, and gives directions for using this instrument to try a current at different depths.

Dr. Brewster, in his edition of Ferguson's lectures, recommends a small and light wheel, like an undershot water-wheel, with float-boards on its circumference. It is provided with an apparatus to ascertain and record the number of turns it makes, and is held in the stream, so that the water may act upon the float-boards to turn it round; and from the number of turns it makes in any given time, the velocity of the stream may be computed. He directs the wheel to be made of the lightest materials, and about ten or twelve inches in diameter: it is furnished with fourteen or sixteen float-boards. The centre of the wheel is perforated with a hole, and tapped to receive a delicate screw or wire, which forms the axis upon which it revolves, with as little friction as possible. At each end of the screw or axis, is a handle to hold it by, and to support the wheel; and to one of these handles an index is fixed, pointing to divisions on the circumference of the wheel, which consist of 100 parts. This index shews the aliquot parts of a revolution, whilst the number of threads which the wheel advances on the screw shews the number of whole turns it makes.

To prepare this instrument for use, the wheel must be turned round upon the screw until it arrives quite at one end of it, and till the index points to zero of the divisions on the rim of the wheel; then hold the axis or screw horizontally by the two handles, so that the floats dip in the water and turn the wheel round upon the screw.

By means of a stop-watch, or a pendulum, find how many revolutions of the wheel are performed in a given time, a minute, for instance. Multiply the mean circumference of the wheel, *i. e.* the circumference deduced from the mean radius, measured from the centre of impulsion upon the float-boards to the centre of the wheel, by the number of revolutions, and the product will be the number of feet which the water moves through in the given time. On account of the friction of the screw, the resistance of the air, and the weight of the wheel, its circumference, will move with a velocity a little less than that of the stream; but the diminution arising from these causes, may be estimated with sufficient precision for all the purposes of the practical mechanic.

This, we think, is one of the best stream-measurers, because it will give a correct measure of the motion at the surface of the water; but it will not give the velocities at the different depths beneath the surface, nor do we know any machine which will effectually answer that purpose.

By means of this instrument, we can obtain the velocity of the surface with greater accuracy than perhaps by any other means; but to ascertain the quantity of water which shall

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shall be discharged, we must know the mean velocity of the water.

Ratio between the mean Velocity of running Water and the Velocity of the Top and Bottom of a Channel.—M. Du Buat states, that the superficial velocity of a stream of water always bears a certain relation to the mean velocity, so that we can derive one from the other by an arithmetical rule.

From a great number of experiments, he discovered the following laws: 1st, That the velocity at the surface in the middle of the stream, (in slow motions,) is to the velocity at the bottom of the stream, in a ratio of considerable inequality. 2d, This ratio diminishes as the velocity increases, and in very great velocities approaches to the ratio of equality. 3d, What was most remarkable, was, that neither the magnitude of the channel, nor its slope, had any influence in changing this proportion, whilst the mean velocity remained the same. Whether the stream ran in a channel with the bottom covered with pebbles, or coarse sand, the proportions between the two velocities was, as nearly as possible, the same as when it ran in a smooth channel. 4th, If the velocity at the surface in the middle of the stream be constant, the velocity at the bottom will be also constant, and will not be affected by the depth of water or magnitude of the stream. In some experiments, the depth was thrice the width, and in others the width was thrice the depth. This changed the proportion of the magnitude of the section, to the magnitude of the rubbing part, but made no change in the ratio between the velocities at the top and bottom.

The place of the mean velocity in the section of the stream could not be discovered with any precision. In moderate velocities, it was not more than one-fourth or one-fifth of the depth distant from the bottom. In very great velocities, it was sensibly higher, but never in the middle of the depth.

In all cases he computed the mean velocity by measuring the quantities of water discharged in a given time. His method of measuring the bottom velocity was simple, and probably just; he threw in a gooseberry, as nearly as possible of the same specific gravity with the water; it was carried along the bottom without touching it. We have already observed, that the ratio between the velocity at the surface in the middle, and the velocity at the bottom, diminished as the mean velocity was increased. This variation he was enabled to express in a very simple manner, so as to be easily remembered, and to enable us to find any one of them from having observed another.

Dr. Robison states, that if we take unity from the square root of the superficial velocity, in the middle of the stream, expressed in inches *per second*, the square of the remainder is the velocity at the bottom; and the mean velocity is the half sum of these two. Thus, if the velocity of the surface in the middle of the stream be twenty-five inches *per second*, its square root is five; from which if we take unity, there remains four. The square of this, or 16, is the velocity

at the bottom, and $\frac{25 + 16}{2}$, or $20\frac{1}{2}$, is the mean velocity.

This is a very curious and most useful piece of information. The velocity of the surface in the middle of the stream, is the easiest measured of all, by any light small body floating down it, or by a stream-measurer; and the mean velocity is the one which regulates the discharge, and all the most important consequences.

Dr. Robison gives the following table of these three velocities, which will save the trouble of calculation in some of the most frequent questions of hydraulics.

Velocity in Inches <i>per Second</i> .			Velocity in Inches <i>per Second</i> .		
Surface.	Bottom.	Mean.	Surface.	Bottom.	Mean.
1	0.000	0.5	51	37.712	44.356
2	0.172	1.081	52	38.564	45.282
3	0.537	1.768	53	39.438	46.219
4	1.	2.5	54	40.284	47.142
5	1.526	3.263	55	41.165	48.082
6	2.1	4.050	56	42.016	49.008
7	2.709	4.854	57	42.968	49.984
8	3.342	5.67	58	43.771	50.886
9	4.	6.5	59	44.636	51.818
10	4.674	7.337	60	45.509	52.754
11	5.369	8.184	61	46.376	53.688
12	6.071	9.036	62	47.259	54.629
13	6.786	9.893	63	48.136	55.568
14	7.553	10.756	64	49.	56.5
15	8.254	11.622	65	49.872	57.436
16	9.	12.5	66	50.751	58.376
17	9.753	13.376	67	51.639	59.319
18	10.463	14.231	68	52.505	60.252
19	11.283	15.141	69	53.392	61.196
20	12.055	16.027	70	54.273	62.136
21	13.674	16.837	71	55.145	63.072
22	13.616	17.808	72	56.025	64.012
23	14.202	18.701	73	56.862	64.932
24	15.194	19.597	74	57.790	65.895
25	16.	20.5	75	58.687	66.843
26	16.802	21.401	76	59.568	67.784
27	17.606	22.303	77	60.451	68.725
28	18.421	23.210	78	61.340	69.670
29	19.228	24.114	79	62.209	70.605
30	20.044	25.022	80	63.107	71.553
31	20.857	25.924	81	64.	72.5
32	21.678	26.839	82	64.883	73.441
33	22.506	27.753	83	65.780	74.390
34	23.339	28.660	84	66.651	75.325
35	24.167	29.583	85	67.568	76.284
36	25.	30.5	86	68.459	77.229
37	25.827	31.413	87	69.339	78.169
38	26.667	32.333	88	70.224	79.112
39	27.51	33.255	89	71.132	80.066
40	28.345	34.172	90	72.012	81.006
41	29.192	35.096	91	70.915	81.957
42	30.030	36.015	92	73.788	82.894
43	30.880	36.940	93	74.719	83.859
44	31.742	37.871	94	75.603	84.801
45	32.581	38.790	95	76.51	85.755
46	33.432	39.716	96	77.370	86.685
47	34.293	40.646	97	78.305	87.652
48	35.151	41.570	98	79.192	88.596
49	36.	42.5	99	80.120	89.56
50	36.857	43.428	100	81.	90.5

The knowledge of the velocity at the bottom is of use to an engineer, to enable him to judge of the action of a stream on its bed. Every kind of soil will bear a certain velocity without changing the form of the channel. A greater velocity would enable the water to tear it up, and a smaller velocity would permit the deposition of more movable materials

rials from above. It is not enough, then, for the permanency of a river, that the accelerating forces are so adjusted to the size and figure of its channel, that the current may acquire an uniform velocity, and cease to accelerate. It must also be in equilibrio with the tenacity of the channel.

It appears from observation, that a velocity of three inches *per second* at the bottom, will just begin to work upon fine clay fit for pottery, and however firm and compact it may be, it will tear it up. Yet no beds are more stable than clay, when the velocities do not exceed this, for the water soon takes away the impalpable particles of the superficial clay, leaving the particles of sand sticking by their lower half in the rest of the clay, which they now protect, making a very permanent bottom, if the stream does not bring down gravel or coarse sand, which will rub off this very thin crust, and allow another layer to be worn off. A velocity of six inches *per second*, will lift fine sand; eight inches will lift sand as coarse as linseed; twelve inches will sweep along fine gravel; twenty-four inches will roll along rounded pebbles an inch in diameter; and it requires three feet *per second* at the bottom to sweep along shivered angular stones of the size of an egg.

Dr. Young gives an excellent simple rule for the same object, which is only a trifle different from Dr. Robison's; he states, that from a mean of all the best experiments, he found that, if the square root of the mean velocity of any stream (running in an uniform open channel) be added to such mean velocity, it will give the superficial or top velocity in the middle; or if deducted therefrom, it will leave the bottom velocity: whence we have deduced the following practical rule, *viz.*

1. Having found the top velocity, expressed in any convenient measure, which will correspond with the result required.

To find the bottom velocity, add the constant number .25 (or $\frac{1}{4}$) to the top velocity; extract the square root of the sum, and double it; again add 1 to the top velocity, and from the sum deduct the double root before found: the remainder is the bottom velocity of the stream.

2. To find the mean velocity from the top velocity, add the constant number .5, (or $\frac{1}{2}$) to the top velocity, and from their sum deduct the square root found in the first rule: the remainder is the mean velocity.

Or, 3. To find the mean velocity from the bottom velocity, add the constant number .25, (or $\frac{1}{4}$) to the bottom velocity, and extract the square root of the sum; then to this square root add the bottom velocity, and the constant number, .5, and their sum is the mean velocity.

These are true in all cases, provided the top and bottom velocities are related to each other, as Dr. Young states. For example, Mr. Watt observed the surface of the water in an open canal to move with a velocity of 17 inches *per second*: What was the bottom velocity?

By our first rule $17 + .25 = 17.25$, of which extract the square root; it is 4.15; twice this is 8.3. Again, to the top velocity 17 add 1 = 18, and deduct 8.3, it leaves 9.7 for the bottom velocity. Mr. Watt observed the bottom velocity to be 10 inches *per second*.

2. To find the mean velocity, add .5 to the top velocity 17, it gives 17.5; deduct 4.18, and we get 13.32 inches *per second* for the mean velocity.

3. If we take Mr. Watt's observation of the bottom velocity of 10 inches *per second*, instead of the top; then to find the mean velocity $10 + .25 = 10.25$, of which the square root is 3.201; and $10 + .5 = 10.5$; add these together, thus $(3.201 + 10.5) = 13.701$ inches *per second* for the

mean velocity; which only exceeds that deduced from the top velocity by little more than $\frac{1}{4}$ of an inch in a second.

By the aid of this rule, and the wheel stream-measurer before described, great accuracy may be obtained. Care must be taken to apply the wheel in the centre of the stream, on the surface, or rather at that place where the velocity of the surface is found to be the greatest.

Second Method of measuring the Flowing of Water in an open Canal.—When a river flows with an uniform motion, and is neither accelerated nor retarded by the action of gravitation, it is obvious that the whole weight of the water must be employed in overcoming the friction of the water against the bottom and sides.

The principal part of this friction is as the square of the velocity, and the friction is nearly the same at all depths: for professor Robison found, that the flow of the fluid through a bent tube was not increased by increasing the pressure against the sides, being nearly the same when the bended part of the tube was situated horizontally, as when vertically, the same difference of level being preserved.

The quantity of friction will, however, vary, according to the surface of the fluid which is in contact with the solid, in proportion to the whole quantity of fluid; that is, the friction for any given quantity of water will be, as the surface of the bottom and sides of a river directly, and as the whole quantity of water in the river inversely; thus, supposing the whole quantity of water to be spread on a horizontal surface equal to the bottom and sides of the river, the friction is inversely as the depth at which the river would then stand. This is called the hydraulic mean depth.

If the inclination or slope of the surface of water in a river varies, the descending weight, or the force that urges the particles down the inclined plane, will vary as the height of the fall in a given distance; consequently, the friction, which is equal to the descending weight, must vary as the fall; and the velocity being as the square root of the friction, must also be as the square root of the fall. Supposing the hydraulic mean depth to be increased or diminished, the inclination remaining the same, the friction would be diminished or increased in the same ratio; and, therefore, in order to preserve its equality with the descending weight, the friction must be increased or diminished, by increasing the velocity in the ratio of its square to the hydraulic mean depth; that is, increasing the velocity in the ratio of the square root of the hydraulic mean depth.

Mr. Eytelwein's Rule is, that the velocity of a stream will be in the joint proportion of the square root of the hydraulic mean depth, and the square root of the fall in a given distance; or as a mean proportional between these two quantities.

Taking two English miles for a given length upon a stream, we must find a mean proportional between its hydraulic mean depth and its fall in two miles in inches, and inquire what relation this bears to the velocity in a particular case. We may thence expect to determine it in any other. According to Mr. Eytelwein's formula, this mean proportional is $\frac{1}{4}$ ths of the velocity in a second in inches.

In order to examine the accuracy of this rule, we may take an example, which could not have been known to Mr. Eytelwein. Mr. Watt observed, that in a canal 18 feet wide above, and 7 below, and 4 feet deep, having a fall of 4 inches in a mile, the velocity was 17 inches *per second* at the surface, 14 in the middle, and 10 at the bottom. The mean velocity may be called $13\frac{3}{4}$ inches, in a second. Now to find the hydraulic mean depth, we must divide the area of the

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the section $\left(\frac{18+7}{2} \times 4\right) = 50$ square feet, by the breadth of the bottom and length of the sloping sides added together; whence we have $\frac{50}{20.6}$, or 29.13 inches: and the fall in two miles being 8 inches, we have $\sqrt{8 \times 29.13} = 15.26$ for the mean proportional; $\frac{1}{4}$ ths of which is 13.9, agreeing nearly with Mr. Watt's observation. Professor Robison has deduced from Buat's elaborate theorems 12.568 inches for the velocity, which is considerably less accurate.

For another example we may take the river Po, which falls one foot in two miles, where its mean depth is 29 feet, and its velocity is observed to be about 55 inches in a second. Our rule gives 58, which is perhaps as near as the degree of accuracy of the data will allow.

On the whole, we have ample reason to be satisfied with the unexpected coincidence of so simple a theorem with observation; and in order to find the velocity of a river from its fall, or the fall from its velocity, we have only to recollect that the velocity in inches *per* second is $\frac{1}{4}$ ths of a mean proportional between the hydraulic mean depth and the fall in two English miles in inches. This is, however, only true of a straight river flowing through an equable channel.

For the slope of the banks of a river or canal, Mr. Eytelwein recommends, that the breadth at the bottom should be $\frac{2}{3}$ ds of the depth, and at the surface $\frac{1}{2}$ ds; the banks will then be in general capable of retaining their form. The area of such a section, is twice the square of the depth, and the hydraulic mean depth $\frac{2}{3}$ ds of the actual depth.

M. Du Buat's Rule.—In our article RIVER, we have given the theorem of M. Du Buat for calculating the motion of water in a river or other regular channel, or through pipes. It has been observed by the late Dr. Robison, that the comparison of the chevalier Du Buat's calculations with his experiments is very satisfactory; that it exhibits a beautiful specimen of the means of expressing the general result of an extensive series of observations in an analytical formula; and that it does honour to the penetration, skill, and address of M. Du Buat, and of M. De St. Honore, who assisted him in the construction of his expressions.

Dr. Young's Rule.—Dr. Young justly remarks, in an excellent paper in the Philosophical Transactions for 1808, that the form of Du Buat's expressions is not so convenient for practice as they might have been rendered; and are liable to great objections, in particular cases: for when the pipe is extremely narrow, or extremely long, they become completely erroneous. Dr. Young has, therefore, substituted for the formulæ of M. Du Buat others of a totally different nature; and he professes to have followed Du Buat only, in his general mode of considering a part of the pressure, or of the height of a given fall, as employed in overcoming the friction of the pipe, through which the water flows out of it; a principle which, if not of his original invention, was certainly first published by him, and reduced into a practicable form. We find Mr. Smeaton used it in constructing his MS. tables. By comparing the experiments which Du Buat has collected, with some of Gerstner's, and some of his own, Dr. Young discovered a formula, which appears to agree fully as well as Du Buat's, with the experiments from which his rules were deduced, and at the same time accords better with Gerstner's experiments; and which formula extends to all the extreme cases with equal accuracy. It seems to represent more simply the actual operation of the forces concerned; and it is direct in its application to practice, without the necessity of any successive approximations.

He began by examining the velocity of the water discharged through pipes of a given diameter, with different

degrees of pressure; and found that the friction could not be represented by any single power of the velocity, although it frequently approached to the proportion of that power of the velocity, of which the exponent is 1.8; but that it appeared to consist of two parts, the one varying simply as the velocity, the other as its square. The proportion of these parts to each other must, however, be considered as different, in pipes of different diameters; the first part being less perceptible in very large pipes, or in rivers, but becoming greater than the second in very minute tubes; while the second also becomes greater, for each given portion of the internal surface of the pipe, as the diameter is diminished.

If, with Dr. Young, we express all the measures in English inches, calling the height employed in overcoming the friction f , the velocity in a second v , the diameter of the pipe d , and its length l ; we may make

$$f = a \frac{l}{d} v^2 + 2c \frac{l}{d} v: \text{ for it is obvious, that the fric-}$$

tion must be directly as the length of the pipe; and since the pressure is proportional to the area of the section, and the surface producing the friction to its circumference or diameter, the relative magnitude of the friction must also be inversely as the diameter, or nearly so, as Du Buat has justly observed.

We shall then find, that a must be .0000001 $\left(413 + \frac{75}{d} - \frac{1440}{d+12.8} - \frac{180}{d+.355}\right)$, and c must be .0000001 $\left(\frac{900dd}{dd+1136} + \frac{1}{\sqrt{d}} \left(1085 + \frac{13.21}{d} + \frac{1.0563}{dd}\right)\right)$.

Hence it is not difficult to calculate the velocity for any given pipe, open canal or river, with any given column of water: for the height required for producing the velocity, including friction, is, according to Du Buat, $\frac{v^2}{510}$;

or rather, as it appears from almost all the experiments which the doctor compared, $\frac{v^2}{586}$; and the whole height b

is, therefore, equal to $f + \frac{v^2}{586}$, or $b = \left(\frac{al}{d} + \frac{1}{586}\right) v^2 + \frac{2cl}{d} v$; and assuming $b = \frac{1}{al \div d + .00171}$, and also

assuming $e = \frac{bcl}{d}$, we have $v^2 + 2cv = bb$; whence, $v = \sqrt{bb + e^2} - e$; which is a general theorem.

In order to adapt this formula to the case of rivers, we must make l (the length) infinite; by which b becomes $\frac{d}{aP}$ and $bb = \frac{d}{a} \times \frac{b}{l} = \frac{ds}{a}$; s being the sine of the inclination of the water's surface, and $d = 4$ times the hydraulic mean depth. The hydraulic mean depth is the area of the section of the moving water, divided by as much of the circumference of that area, as the water touches. And since e is here $= \frac{c}{a} v = \frac{\sqrt{ads + e^2} - c}{a}$; and in most rivers, v becomes nearly $\sqrt{20000ds}$.

Another useful rule by Dr. Young, is to find the superficial velocity of the water in a river by adding to the mean velocity

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velocity of a river its square root; this gives the velocity at the surface; and by subtracting the same square root, we get the velocity at the bottom.

N. B. $2.618 - \sqrt{2.618} = 1$, and $.382 + \sqrt{.382} = 1$; which it may be useful to remember, with reference to this last rule.

Dr. Young made a comparison of his general theorem, as above, with forty experiments extracted from the collection which served as a basis for Du Buat's calculations; and he found that the mean error of his formula is $\frac{1}{3}$ th of the whole velocity, and that of his own $\frac{1}{7}$ th only. But, omitting the four experiments, in which the superficial velocity only of a river was observed, and in which he calculated the mean velocity by Du Buat's rules, the mean error of the remaining 36 is but $\frac{1}{3}$ th, according to Dr. Young's mode of calculation, and $\frac{1}{7}$ th according to M. Du Buat's; so that, on the whole, the accuracy of the two formulæ may be considered as precisely equal with respect to these experiments.

In the six experiments which Du Buat has wholly rejected, the mean error of his formula is about $\frac{1}{3}$ th, and that of Dr. Young's $\frac{1}{7}$ th. In fifteen of Gerstner's experiments, the mean error of Du Buat's rule is $\frac{1}{4}d$, that of Dr. Young's $\frac{1}{4}$ th; and in the three experiments which Dr. Young made with very fine tubes, the error of his own rules is $\frac{1}{3}$ th of the whole; while in such cases Du Buat's formulæ completely fail.

It would be useless to seek for a much greater degree of accuracy, unless it were probable that the errors of the expe-

riments themselves were less than those of the calculations. But if a sufficient number of extremely accurate and frequently repeated experiments could be obtained, it would be very possible to adapt Dr. Young's formula still more correctly to their results.

In order to facilitate the computation, Dr. Young made tables of the co-efficients a and c for 44 different values of a , both in French and English inches, which may be seen in the Philosophical Transactions for 1808; but instead of inserting them, we shall give a far more extended table, which we have carefully deduced from Dr. Young's formula and table, and put it in a form more directly applicable to practice.

Let d represent four times the hydraulic mean depth of an open canal.

Note.—The hydraulic mean depth is the area of the section through which the water runs, divided by so much of the circumference of that section as is touched by the water.

Note also.—In case of close pipes running a full bore of water, the diameter of the pipe is four times the hydraulic mean depth.

s represents the sine of the inclination of the water's surface; that is, the height of the head or rise, divided by the length or distance of the slope in which such rise takes place.

v , the mean velocity *per second*, in inches.

The other symbols used in the theorem are shewn at the head of the different columns of the Table.

WATER.

Dr. Thomas Young's Theorem, with a new and enlarged Table deduced therefrom, expressly for our Work, for calculating the Velocity of Water flowing in Rivers, Channels, or Pipes.

THEOREM. The mean Velocity *per* Second, in inches or *v*, is = $\sqrt{\left(\frac{d}{a^3} + \frac{c^2}{a^2}\right) - \frac{c}{a}}$

<i>d</i>	$\frac{d}{a}$	$\frac{c^2}{a^2}$	$\frac{c}{a}$	<i>d</i>	$\frac{d}{a}$	$\frac{c^2}{a^2}$	$\frac{v}{a}$
0.5	20410	41.477	6.441	64	1629000	4.576	2.139
1.0	39840	19.171	4.379	65	1654000	4.611	2.147
1.5	56820	11.468	3.386	66	1679000	4.645	2.155
2.0	72730	7.922	2.815	67	1703000	4.678	2.163
2.5	88030	5.972	2.444	68	1728000	4.709	2.170
3	102700	4.729	2.175	69	1752000	4.739	2.177
4	131600	4.363	2.089	70	1777000	4.769	2.184
5	159700	2.624	1.620	71	1801000	4.796	2.190
6	186900	2.153	1.467	72	1826000	4.823	2.196
7	214100	1.885	1.373	73	1850000	4.848	2.202
8	241000	1.701	1.304	74	1875000	4.872	2.207
9	267900	1.570	1.253	75	1899000	4.894	2.212
10	295000	1.506	1.227	76	1923000	4.915	2.217
11	321600	1.469	1.212	77	1947000	4.936	2.222
12	347800	1.450	1.204	78	1971000	4.956	2.226
13	373600	1.443	1.201	79	1996000	4.976	2.231
14	398900	1.418	1.191	80	2020000	4.995	2.235
15	423700	1.476	1.215	81	2044000	5.013	2.239
16	449400	1.521	1.233	82	2068000	5.030	2.243
17	474900	1.566	1.251	83	2093000	5.046	2.246
18	500000	1.612	1.269	84	2117000	5.061	2.249
19	524900	1.664	1.290	85	2141000	5.076	2.253
20	549500	1.717	1.310	86	2165000	5.091	2.256
25	673900	2.010	1.418	87	2189000	5.106	2.259
30	795800	2.508	1.584	88	2213000	5.121	2.263
35	918600	2.929	1.711	89	2237000	5.135	2.266
40	1042000	3.304	1.818	90	2261000	5.149	2.269
45	1163000	3.636	1.907	91	2285000	5.162	2.272
50	1285000	3.939	1.984	92	2309000	5.175	2.275
51	1310000	3.988	1.997	93	2333000	5.188	2.277
52	1334000	4.041	2.010	94	2357000	5.200	2.280
53	1359000	4.093	2.023	95	2381000	5.212	2.283
54	1383000	4.144	2.036	96	2405000	5.224	2.286
55	1408000	4.194	2.048	97	2429000	5.236	2.288
56	1433000	4.243	2.060	98	2453000	5.248	2.291
57	1457000	4.290	2.071	99	2477000	5.260	2.293
58	1482000	4.335	2.082	100	2501000	5.272	2.296
59	1506000	4.380	2.093	200	4950000	5.541	2.354
60	1531000	4.423	2.103	300	7371000	5.460	2.337
61	1556000	4.465	2.113	400	9780000	5.372	2.318
62	1580000	4.504	2.122	500	12200000	5.301	2.302
63	1605000	4.541	2.131	Infinite	—	4.749	2.179

Use of the Table.—To render this theorem useful to those who are not familiar with the use of algebraic expressions, we shall give an example of the manner of calculating a stream of water, all the operations being performed by common arithmetic, with the help of the preceding Table.

1. If it is a stream of water running in an uniform channel, take a sufficient number of dimensions of the transverse section of the channel, and by the rules of mensuration calculate the area of its cross section in square feet. Calculate also, how much of the circumference of such cross section is touched by the water, not including its level top.

Then divide the area in square feet by that portion of the circumference in feet, in order to obtain the hydraulic mean depth; this must be multiplied by 12, to reduce it to inches. Multiply the quotient by 4, and the result is d , the number which is to be sought in the first column of the preceding Table.

If it is a circular pipe of uniform bore, running full of water, its internal diameter, taken in inches, is already equal to four times the hydraulic mean depth, without any computation; and accordingly the diameter of the pipe in inches is to be sought for in column 1.

2. By a spirit-level or otherwise, ascertain the perpendicular fall or difference of level, between any two distant points on the surface of the water, if it is an open stream, and find the distance between these points of levelling, by measuring upon a parallel to the surface of the stream. These may be taken in any convenient measures; but the fall and the distance must be reduced to the same measures; then divide the fall by the distance, and the quotient is s , or a decimal number, which is the sine of the inclination of the stream.

If it be a close pipe, the perpendicular fall must be the difference of level between the surface of the reservoir and the place of discharge; divide this by the length of the pipe.

3. Having found d , in column 1 of the Table, take out the number opposite to it in the second column, entitled $\frac{d}{a}$ (that is, d divided by a), and multiply this tabular number by the decimal number s .

Note.—It will sometimes happen that the exact amount of d is not to be found in column 1, but it will fall between two of the numbers therein; then take out the least of those numbers before d , and find how much is to be added thereto, by the following rule: Take the difference of the two numbers in col. 1. between which d falls; also the difference of the numbers opposite to them in col. 2.; also take the difference between the number d , and the least of the two numbers between which it falls. Now, by the Rule of Three, say, as the whole difference of the two numbers in col. 1. is to the same in col. 2., so is the difference between d and the number above it in col. 1. to a fourth number, which is the proportional part to be added to the number of col. 2. before d .

4. Take out the tabular number from col. 3. which is entitled $\frac{c^2}{a^2}$; (that is, the square of c divided by the square of a).

But here *note*, in case of calculating a proportional part, (as directed in the last rule,) it is not always to be added (as in col. 2.); but sometimes, on the contrary, it is to be subtracted, accordingly as the numbers in that part of col. 3. are increasing or decreasing; and for greater ease of discovering this, a * is placed opposite 14, and between 200 and 300 of col. 1., to shew the places where these changes take place, from decrease to increase, and the contrary.

5. Multiply s , the result of the second operation, and $\frac{d}{a}$, the result of the third operation, together, and to the product add $\frac{c^2}{a^2}$, as found by the fourth operation: then extract the square root of this sum.

6. Take out $\frac{c}{a}$ from col. 4., and apply the proportional part as before, if necessary; deduct this number $\frac{c}{a}$ from the square root last found, and the remainder or result is the mean velocity of the stream in inches per second, which was required.

Should this result be afterwards wanted in feet per minute, the numbers last obtained must be multiplied by 60, and divided by 12; or rather, multiplied at once by 5, which is the same thing.

To obtain the quantity of water discharged in a minute; multiply the area of the section of the stream by the velocity now found; taking care, if the area is in square feet, to express the velocity of the water in feet; or if the area is in square inches, the velocity must be expressed in inches, and the product or result will be in cubic feet or cubic inches, accordingly.

Example 1.—The Academy of Sciences at Paris were occupied, during several months, with an examination of a plan proposed by M. Parcieux, for bringing the water of Yvette into Paris; and, after the most mature consideration, gave in a report of the quantity of water which M. De Parcieux's aqueduct would yield. Their report was afterwards found erroneous in the proportion of at least 2 to 5; for when the waters were brought in, they exceed the report in this proportion. Indeed, long after the giving in the report, M. Perronet, the most celebrated engineer in France, affirmed, that the dimensions proposed were much greater than were necessary; and said that an aqueduct of $5\frac{1}{2}$ feet wide, and $3\frac{1}{2}$ deep, with a slope of 15 inches in a thousand fathoms, would have a velocity of 12 or 13 inches per second, and would bring all the water furnished by the proposed sources. The great diminution of expence occasioned by the alteration, encouraged the community to undertake the work. It was accordingly began, and partly executed. The water was found to run with a velocity of near 19 inches, when it was $3\frac{1}{2}$ feet deep.

M. Perronet founded his computation on his own experience alone, acknowledging that he had no theory to instruct him.

Let us examine this case by our theorem.

First, The area of the section is 3.5 feet deep \times by 5.5 feet wide = 19.25 square feet.—The circumference which the water touches, consists of the two sides of 3.5 feet each, added to 5.5 feet, the bottom = 12.5 feet. The area 19.25 square feet divided by 12.5 feet gives 1.54 feet, for the hydraulic mean depth \times 12 = 18.48 inches; four times this is $d = 73.92$, which we are to seek in the first column of the table; and may take 74.

Secondly, To find s , take the fall 15 inches, or 1.33 feet, and divide it by the distance, 1000 fathoms, or 6000 feet; the result is .00022, for s , or the sine of the inclination.

Take out from the table the numbers corresponding to 74.

d	$\frac{d}{a}$	$\frac{c^2}{a^2}$	$\frac{c}{a}$
74	1875000	4.872	2.207

WATER.

We now have all the necessary quantities for making the calculation thus: multiply $\frac{d}{a} = 1875000$ by $s = .00022$, and we have 416.25. To this add $\frac{c^2}{a^2} = 4.872$, and it makes 421.122, of which extract the square root, and it is 20.52; deduct $\frac{c}{a} = 2.207$ from this, and it leaves 18.313 inches *per second* for the mean velocity of the water.

This agrees pretty well with the observation of 19 inches, and Dr. Robison made very nearly the same result by a different mode of calculation.

The velocity of 18.313 inches *per second* $\times 5$ gives 91.56 feet *per minute*, and again multiplied by 19.25 square feet, (the area of the section,) gives 1761.6 cubic feet of water which flow through this canal every minute.

This example is comparatively easy, because the table affords the numbers required; but in some cases the exact numbers cannot be found in the table, we shall therefore give another example.

Example 2.—Mr. Watt measured a canal in the neighbourhood of Birmingham, which was 18 feet wide at the surface of the water, 7 feet wide at the bottom, and 4 feet deep. The water had a declivity of four inches in a mile;—required the velocity with which the water moved, and the quantity which the canal afforded.

To have a complete knowledge of the section, find the length of each sloping side, thus take the projection of the top width over the bottom width on each side, that is, half the difference between the top and bottom width $(18 - 7) \div 2 = 5.5$ feet; now the square of 5.5 is 30.25, and the square of 4 feet the depth is 16, the sum of the two is $(30.25 + 16 =) 46.25$; and the square root of this is 6.8, the length of each sloping side.

First, To find the area and the hydraulic mean depth.—The mean between the widths of the top and bottom is $(18 + 7) \div 2 = 12.5$ feet $\times 4$ feet deep = 50 square feet for the area of the section. To find the circumference which the water touches, add the two sloping sides, each 6.8 feet, to 7 feet, the width of the bottom, and it makes 20.6 feet.

The area, 50 square feet, divided by 20.6 feet, gives 2.4272 feet = 29.126 inches for the hydraulic mean depth; 4 times this is 116.504, which is d , and must be found in the first column of the table. The nearest which can there be found is 100 inches.

Secondly, The fall is 4 inches in the distance of a mile, = 63360 inches, divide 4 by 63360, and it gives .00006313 for s , the sine of the inclination.

Thirdly, The value of $\frac{d}{a}$, in the second column, opposite to 100 in the first column, is 2501000, to which something must be added for the 16.5 inches. To find this quantity, take the difference between the adjacent numbers in column two, *viz.* 2501000 and 4950000 = 2449000, and; lastly, the difference between 100 and 116.5 = 16.5; then say, as 100 is to 2449000, so is 16.5 to 404085, which number is to be added to 2501000, = 2905085, which is $\frac{d}{a}$ for 116.5.

Fourthly, The value of $\frac{c^2}{a^2}$, in column third opposite to 100, is 5.272, to which add .0043, as found by a rule of VOL. XXXVIII.

proportion similar to the above, and it gives 5.276, which is $\frac{c^2}{a^2}$ for 116.5.

Fifthly, Multiply $s = .00006313$ by 2905085, and it gives 183.395; add $\frac{c^2}{a^2}$, or 5.276, as found by the preceding operation, and it gives 188.671; and the square root of this number is 13.736.

Sixthly, The value of $\frac{c}{a}$, in column fourth, is 2.296 for 100, or for 116.5 it is 2.297; deduct this from 13.736, the result of the last operation, and we have 11.439, which is the velocity of the stream in inches *per second*, and this $\times 5 = 57.195$ feet *per minute*. To find the quantity, multiply the velocity, 57.19 feet *per minute*, by 50 square feet the area, and we shall have 285.97 cubic feet, which quantity will flow every minute through this canal.

The velocity here found is considerably smaller than what was observed by Mr. Watt; he found the velocity at the surface 17 inches *per second*, and at the bottom 10 inches, the mean velocity we have already calculated at 13.32.

Dr. Robison, in the *Encyclopædia Britannica*, gives a calculation of this same case by Du Buat's formula, which we have given in the article RIVER. He makes the velocity 11.85 feet *per second*, which differs so little from our computation, that the two theorems may be considered equally accurate; but both appear, by Mr. Watt's observation, to be rather too small in very small declivities of rivers and canals. This is not surprising when we consider, that the experiments, which are the foundation of both these formulæ, were made on small canals; but for this reason, we may expect they will be more accurate when applied to smaller channels, such as mill-courses, aqueducts, &c.

In taking observations to apply this method of calculation to practice, it must be recollected that it always proceeds on the supposition, that the canal is of a regular width and depth, and of an uniform slope throughout. If this is not the case, the canal must be considered in different portions, and each calculated separately. We think greater accuracy will be attained by measuring and carefully levelling 100 yards in which the width and depth are quite regular, than by taking a mile in length, if there are any irregularities in the dimensions, or in the slope in that distance.

On the other hand, the theorem cannot apply at all, unless the length of the channel is such, that the water in it will arrive at an uniform motion without any acceleration of the motion, as it proceeds down. In short and rapidly inclined channels, the water accelerates in consequence of descending further down the fall; but when the canal is long, the velocity arrives at a certain point, and then the friction prevents any farther acceleration; in this case, the theorem applies. We shall not err sensibly in using this theorem for canals of 30 yards in length, or less, if the fall is small.

Method of gauging the Water running through close Pipes.—Dr. Young's theorem and our table, apply with equal, perhaps greater accuracy, to the case of close pipes than to open canals.

All that is necessary is, to measure the internal diameter of the pipe in inches, the length of the pipe, and the difference of the level between the water in the reservoir and the place at which the water is discharged, and proceed as in the former instance; but to render it more clear we shall give two examples.

Example 1.—The city of Edinburgh is supplied with
P water,

water, from springs at Comifton, which is a considerable distance; this is conveyed by two pipes, the first of which was laid in 1720, under the direction of Defaguliers. Dr. Robison mentions one of them, which is 5 inches diameter, 14,637 feet in length; the reservoir at Comifton is forty-four feet higher than the reservoir on the Castle-Hill, in the town of Edinburgh.

First, to find the sine of the inclination, or s , divide the fall 44 feet by 14,637, and it gives .00301, which is s .

Now take five inches, the diameter of the pipe in col. 1., and opposite to it in col. 2. find $\frac{d}{a} = 159700$, which multiply by .00301, gives 479.1; to this add $\frac{c^2}{a^2} = 2.624$ taken from the third column, and the sum is 481.724.

Extract the square root of this, and it is 21.948, from which deduct $\frac{c}{a}$, or 1.620, taken from col. 4., and the result is 20.328, which is the velocity in inches per second, and this \times by 5 = 101.64 feet per minute.

To find the quantity, find the area of the section of the pipe in square feet, by dividing the square of the diameter 25 by 183.3, and it gives .1364 square feet, and this \times by 101.64 feet velocity, gives 13.86 cubic feet per minute for the discharge from the pipe.

Dr. Robison's calculation of this same case by Du Buat's formula, gives a velocity of 20.08 inches per second.

In Mr. Smeaton's Reports, we find the other pipe stated at four and a half inches bore, and that it yielded 160 Scots pints per minute, each 103.4 cubic inches = 9.58 cubic feet. Mr. Smeaton's own calculation was 159 pints.

Example 2.—Mr. Smeaton states, that this pipe was improved by obtaining an increase of fall, making it 51 feet, and that it then yielded 200 Scots pints = 11.98 cubic feet per minute, the bore being $4\frac{1}{2}$ inches, and the length 14,637 feet as before. Mr. Smeaton's calculation was 173 pints = 10.36 cubic feet per minute. What would it be by Dr. Young's theorem? viz. velocity =

$$\sqrt{\left(\frac{d}{a} \times s + \frac{c^2}{a^2}\right) - \frac{c}{a}}$$

To find s , divide the fall 51 feet by the length 14,637 feet; it gives .003484.

To find $\frac{d}{a}$, answering to 4.5 inches in col. 1., take half the difference between the numbers in the second col. opposite to 4 and 5, and add it to the number answering to 4; thus, $\frac{d}{a}$ for 4 is 131560, and $\frac{d}{a}$ for 5 is 159700, difference 28200, which $\div 2 = 14100$, and this $\times 131500 = 145600$, which is $\frac{d}{a}$ for 4.5. Multiply this 145600 by s , or .003484, and it is = 507.67; to this add $\frac{c^2}{a^2}$.

To find $\frac{c^2}{a^2}$ for 4.5, take half the difference between the numbers in the third column for 4 and 5, which is .869, and subtract it from 4.363, the number answering to 4; the result is 3.494, which is $\frac{c^2}{a^2}$ for 4.5; this added to 507.67 is 511.164.

The square root of that number is 22.609, from which deduct $\frac{c}{a} = 1.854$, and it leaves 20.755, which is the velocity per second in inches.

(Note. $\frac{c}{a}$ is found by subtracting half the difference between the numbers for 4 and 5 in the fourth column, from the number answering to 4.)

20.755 inches per second $\times 5 = 103.775$ feet per minute, for the velocity. The area of the pipe is $4.5 \times 4.5 = 20.25$ circular inches, which \div by 183.3, the circular inches in a square foot, is = .1104 square feet for the area of the pipe. Multiply this by 103.775 feet per minute, and we get 11.46 cubic feet per minute for the discharge, which agrees very nearly with the experiment.

Dr. Brewster, in his Encyclopædia, has calculated this same pipe, except that he states it 300 feet longer; he makes the velocity by Du Buat's theorem 20.385 inches per second, and says that on an average of five years, from 1738 to 1742, its maximum discharge was 11.3 cubic feet per minute; he has also calculated the same case by five different formulæ; thus,

	Scots Pints per Minute.	Cubic Feet per Minute.
The quantity of water actually discharged	200	11.968
Calculated by Eytelwein's formula	189.4	11.333
Calculated by Girard's formula	189.77	11.355
Calculated by Du Buat's formula	188.26	11.265
Calculated by M. Prony's simple formula	188.13	11.257
Calculated by M. Prony's table	192.32	11.502
To which we may add Mr. Smeaton's calculation	180.7	10.813
And by Dr. Young's theorem	173.	10.352
	191.5	11.459

It is satisfactory to find the results of so many different processes agree so nearly, and gives us great confidence in the truth of the principles. There is in this case so little difference amongst theorems that any one may be taken; but we think it needless to enter into farther particulars, as the one which we have given effects all that can be desired, and by the help of the table, is the most ready in the application.

We shall only add Mr. Smeaton's table on the friction of water running through pipes, which we find in his manuscript papers, and which he computed from his own observations alone, without knowing the experiments on which the other theorems are founded. They will give rather less than the theorems, and perhaps may approach more nearly to actual practice, in which pipes are not laid with the same care, to avoid roughness within and sudden bends, as when prepared purposely for experiments; we may consider the theorems as the maximum discharge, and Mr. Smeaton's table as the fair average of practice.

Use of the Table.—Find the velocity of the water per minute in feet and decimals in the first column, or in feet per second in the next column, and on the same line underneath the diameter of the bore in inches, you will find the perpendicular height of a column of water in inches and 10ths, necessary to overcome the friction of that pipe for 100 feet in length, and obtain the given velocity.

WATER.

Mr. Smeaton's TABLE for shewing the Friction of Water in Pipes; the Bore of the Pipe being given, and the Velocity of the Water therein; the Column or Height of Head necessary to overcome the Friction, and produce that Velocity, is shewn by this Table for 100 Feet in Length.

Velocity.		Bore of the Pipes in Inches.										
		$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	3	$3\frac{1}{2}$
In Feet per Minute.	In Feet per Second.	Depths of Water necessary to overcome the Friction of the Water in a Pipe 100 feet long, and produce the Velocities marked in the two first Columns.										
		Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
5	.083	0.2	0.16	0.12	0.1	0.08	0.07	0.06	0.06	0.05	0.04	0.04
10	.166	0.7	0.5	0.4	0.3	0.25	0.2	0.2	0.17	0.15	0.12	0.10
15	.25	1.2	0.8	0.6	0.5	0.4	0.4	0.3	0.3	0.25	0.2	0.18
20	.33	2.0	1.3	1.0	0.8	0.7	0.6	0.5	0.4	0.4	0.3	0.3
25	.416	3.2	2.1	1.6	1.3	1.1	0.9	0.8	0.7	0.6	0.5	0.5
30	.5	4.5	3.0	2.2	1.8	1.5	1.3	1.1	1.0	0.9	0.7	0.6
35	.58	6.0	4.0	3.0	2.4	2.0	1.7	1.5	1.3	1.2	1.0	0.8
40	.666	8.0	5.3	4.0	3.2	2.7	2.3	2.0	1.8	1.6	1.3	1.1
45	.75	9.5	6.3	4.7	3.8	3.2	2.7	2.4	2.1	1.9	1.5	1.4
50	.833	11.7	7.8	5.9	4.7	3.9	3.4	2.9	2.6	2.3	1.9	1.7
55	.916	14.2	9.5	7.1	5.7	4.7	4.1	3.6	3.2	2.8	2.4	2.0
60	1.	16.7	11.1	8.4	6.7	5.6	4.8	4.2	3.7	3.3	2.8	2.4
65	1.083	19.5	13.0	9.7	7.8	6.5	5.6	4.9	4.3	3.9	3.2	2.8
70	1.166	22.2	14.8	11.1	8.9	7.4	6.4	5.6	4.9	4.4	3.7	3.2
75	1.25	25.0	16.6	12.5	10.0	8.3	7.1	6.2	5.5	5.0	4.2	3.6
80	1.33	28.5	19.0	14.2	11.4	9.5	8.1	7.1	6.3	5.7	4.7	4.1
85	1.416	31.5	21.0	15.7	12.6	10.5	9.0	7.9	7.0	6.3	5.2	4.5
90	1.5	35.0	23.3	17.5	14.0	11.7	10.0	8.7	7.8	7.0	5.8	5.0
95	1.583	38.5	25.6	19.2	15.4	12.8	11.0	9.6	8.6	7.7	6.4	5.5
100	1.66	42.0	28.0	21.0	16.8	14.0	12.0	10.5	9.3	8.4	7.0	6.0
105	1.75	45.7	30.5	22.9	18.3	15.3	13.1	11.4	10.2	9.1	7.6	6.5
110	1.833	49.5	33.0	24.7	19.8	16.5	14.1	12.4	11.0	9.9	8.2	7.1
115	1.916	53.7	35.8	26.9	21.5	17.9	15.4	13.4	11.9	10.7	9.0	7.7
120	2.	57.7	38.5	28.9	23.1	19.2	16.5	14.4	12.8	11.5	9.6	8.2
130	2.166	66.5	44.3	33.2	26.6	22.1	19.0	16.6	14.8	13.3	11.1	9.5
140	2.333	75.7	50.5	37.9	30.3	25.2	21.6	18.9	16.8	15.1	12.6	10.8
150	2.5	85.7	57.2	42.9	34.3	28.6	24.5	21.4	19.0	17.1	14.3	12.2
160	2.33	96.5	64.3	48.2	38.6	32.1	27.6	24.1	21.4	19.3	16.1	13.8
170	2.83	108.5	72.3	54.2	43.4	36.1	31.0	27.1	24.1	21.7	18.1	15.5
180	3.	121.0	80.6	60.5	48.4	40.3	34.6	30.2	26.9	24.2	20.2	17.3
190	3.166	134.5	89.6	67.2	53.8	44.8	38.2	33.6	29.9	26.9	22.4	19.2
200	3.333	149.0	99.3	74.5	59.6	49.7	42.6	37.2	33.1	29.8	24.8	21.3
210	3.5	164.0	109.3	82.0	65.6	54.7	46.9	41.0	36.4	32.8	27.3	23.4
220	3.666	180.0	120.0	90.0	72.0	60.0	51.4	45.0	40.0	36.0	30.0	25.7
230	3.833	196.5	131.0	98.2	78.6	65.5	56.1	49.1	43.7	39.3	32.7	28.1
240	4.	214.0	142.6	107.0	85.6	71.3	61.1	53.5	47.6	42.8	35.7	30.6
255	4.25	241.2	160.8	120.6	96.5	80.4	68.9	60.3	53.6	48.2	40.2	34.5
270	4.5	270.7	180.5	135.4	108.3	90.2	77.4	67.7	60.1	54.1	45.1	38.7
285	4.75	301.5	201.0	150.7	120.6	100.5	86.1	75.4	67.0	60.3	50.2	43.1
300	5.	336.2	224.1	168.0	134.5	112.1	96.1	84.0	74.7	67.2	56.0	48.0
		$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	3	$3\frac{1}{2}$
Bore of the Pipes in Inches.												

WATER.

Mr. Smeaton's Table for the Friction in Water in Pipes—*Continued.*

Velocity.		Bore of the Pipes in Inches.										
		4	4½	5	6	7	8	9	10	11	12	
In Feet <i>per</i> Minute.	In Feet <i>per</i> Second.	Depths of Water necessary to overcome the Friction of the Water in a Pipe 100 feet long, and produce the Velocities marked in the Two first Columns.										
		Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
5	.083	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
10	.166	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.04	0.03	0.03
15	.25	0.15	0.14	0.12	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.05
20	.33	0.25	0.2	0.2	0.17	0.14	0.12	0.11	0.10	0.09	0.08	0.08
25	.416	0.4	0.4	0.3	0.3	0.2	0.2	0.18	0.16	0.15	0.14	0.14
30	.5	0.6	0.5	0.4	0.4	0.3	0.3	0.25	0.2	0.20	0.19	0.19
35	.58	0.8	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.27	0.25	0.25
40	.666	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.4	0.36	0.3	0.3
45	.75	1.2	1.1	0.9	0.8	0.7	0.6	0.5	0.5	0.4	0.4	0.4
50	.833	1.5	1.3	1.2	1.0	0.8	0.7	0.6	0.6	0.5	0.5	0.5
55	.916	1.8	1.6	1.4	1.2	1.0	0.9	0.8	0.7	0.6	0.6	0.6
60	1.	2.1	1.9	1.7	1.4	1.2	1.0	0.9	0.8	0.8	0.7	0.7
65	1.083	2.4	2.2	1.9	1.6	1.4	1.2	1.1	1.0	0.9	0.8	0.8
70	1.166	2.8	2.5	2.2	1.9	1.6	1.4	1.2	1.1	1.0	0.9	0.9
75	1.25	3.1	2.8	2.5	2.1	1.8	1.6	1.4	1.2	1.1	1.0	1.0
80	1.33	3.6	3.2	2.8	2.4	2.0	1.8	1.6	1.4	1.3	1.2	1.2
85	1.416	4.0	3.5	3.1	2.6	2.2	2.0	1.7	1.6	1.4	1.3	1.3
90	1.5	4.4	3.9	3.5	2.9	2.5	2.2	1.9	1.7	1.6	1.5	1.5
95	1.583	4.8	4.3	3.8	3.2	2.7	2.4	2.1	1.9	1.7	1.6	1.6
100	1.66	5.2	4.7	4.2	3.5	3.0	2.6	2.3	2.1	1.9	1.8	1.8
105	1.75	5.7	5.1	4.6	3.8	3.3	2.9	2.5	2.3	2.1	1.9	1.9
110	1.833	6.2	5.5	4.9	4.1	3.5	3.1	2.7	2.5	2.2	2.1	2.1
115	1.916	6.7	6.0	5.4	4.5	3.8	3.4	3.0	2.7	2.4	2.2	2.2
120	2.	7.2	6.4	5.8	4.8	4.1	3.6	3.2	2.9	2.6	2.4	2.4
130	2.166	8.3	7.4	6.6	5.5	4.7	4.2	3.7	3.3	2.9	2.8	2.8
140	2.333	9.5	8.4	7.6	6.3	5.4	4.7	4.2	3.8	3.4	3.2	3.2
150	2.5	10.7	9.5	8.6	7.1	6.1	5.4	4.8	4.3	3.9	3.6	3.6
160	2.33	12.1	10.7	9.6	8.0	6.9	6.0	5.4	4.8	4.4	4.0	4.0
170	2.83	13.6	12.1	10.8	9.0	7.7	6.8	6.0	5.4	4.9	4.5	4.5
180	3.	15.1	13.4	12.1	10.1	8.6	7.6	6.7	6.0	5.5	5.0	5.0
190	3.166	16.8	15.0	13.4	11.2	9.6	8.4	7.5	6.7	6.1	5.6	5.6
200	3.333	18.6	16.6	14.9	12.4	10.6	9.3	8.3	7.4	6.8	6.2	6.2
210	3.5	20.5	18.2	16.4	13.7	11.7	10.2	9.1	8.2	7.5	6.8	6.8
220	3.666	22.5	20.0	18.0	15.0	12.9	11.2	10.0	9.0	8.2	7.5	7.5
230	3.833	24.6	21.8	19.6	16.4	14.0	12.3	10.9	9.8	9.0	8.2	8.2
240	4.	26.7	23.8	21.4	17.8	15.3	13.4	11.9	10.7	9.7	8.9	8.9
255	4.25	30.1	26.8	24.1	20.1	17.2	15.1	13.4	12.0	11.0	10.1	10.1
270	4.5	33.8	30.1	27.1	22.6	19.3	16.9	15.0	13.5	12.3	11.3	11.3
285	4.75	37.7	33.5	30.1	25.1	21.5	18.9	16.7	15.1	13.7	12.6	12.6
300	5.	42.0	37.4	33.6	28.0	24.0	21.0	18.7	16.8	15.3	14.0	14.0
		4	4½	5	6	7	8	9	10	11	12	
		Bore of the Pipes in Inches.										

WATER.

We have searched in Mr. Smeaton's papers for the experiments by which this table was made, and we find an investigation, from the experiments of M. Couplet, as recorded by Belidor, on the flow of water through a large pipe at Versailles. From these he deduced the following rule, to find the height of column in inches, corresponding with the velocities in inches *per* second, through a pipe of any diameter given in inches, and 100 feet long.

$$\frac{48 \times (\text{velocity}) + \text{velocity}^2}{52.66 \times (\text{diameter})} = \text{depth of column};$$

or, still more nearly, taking 47.873 for the constant number instead of 48.

It appears that he found this rule did not agree with his own observations; and, in consequence, he made the following experiments himself with a pipe of $1\frac{1}{4}$ inch bore and 100 feet in length; and we believe he arranged them into the table, by projecting and drawing a curve, at least we find that was his usual method in like cases.

Velocity <i>per</i> Second.	Depth of the Column.	
	By the Table.	By Experiment.
Inches.	Inches.	Inches.
$6\frac{1}{2}$	2.1	2.0
$7\frac{3}{4}$	3.0	2.8
$8\frac{3}{4}$	3.7	3.8
10	4.7	4.8
$11\frac{1}{2}$	6.2	6.2
13.4	7.9	7.8
$15\frac{1}{2}$	10.4	10.7
$18\frac{1}{4}$	14.7	14.5
21	18.3	18.1
$23\frac{3}{4}$	22.7	23.0
27	28.4	27.6
$28\frac{1}{4}$	30.8	30.5
$29\frac{3}{4}$	33.8	34.3
$30\frac{1}{4}$	34.8	35.6
35.5	47.2	47.0
$43\frac{3}{4}$	71.2	71.0

This is useful information, because it shews what part of the table may be depended upon. He assumed, that the depth of the column in pipes of other dimensions, was as the length of the pipe directly, and as the diameters inversely.

The form of this table renders it immediately applicable to a great variety of purposes; for instance, an engine is required to pump water to a height of 60 feet; but the water must pass through 1800 feet of horizontal pipe of 5 inches bore, and with a velocity of 140 feet *per* minute. The table shews, that for every 100 feet of this pipe the friction will be equal to a column of 7.6 inches; multiply this by 18.6, and we find the whole friction will be 141.36 inches, this added to 60 feet makes 71.78 feet for the real column which the pump must overcome.

Rules for measuring the Quantity of Water flowing through Sluices or Apertures.—In this, like the former instances, we must multiply the area of the aperture by the velocity with which the water rushes through it.

Sir Isaac Newton, in his Principia, book ii. theo. 8. prob. 36. has demonstrated, that the velocity of water, flowing through holes in the bottom or side of a vessel, ought to be equal to the velocity which a heavy body would acquire, in falling through a space equal to the distance between the surface of the water and the place where it is discharged.

Hence, at the depth of $16\frac{1}{7}$ feet, a stream of $32\frac{1}{7}$ feet in length, ought to flow out in a second of time. And from the laws of falling bodies, it follows, that as the square root of $16\frac{1}{7}$ is to the velocity of the stream flowing out at that depth, so is the square root of any other depth to the velocity of that depth.

Hence, the velocity of water flowing out of a horizontal aperture, in the bottom of a cistern or reservoir, is as the square root of the height, or the depth of water above the aperture.

That is, the pressure, and consequently the depth, is as the square of the velocity; for the quantity flowing out in any given time is as the velocity, and the force required to produce a velocity in a certain quantity of matter in a given time, is also as that velocity; therefore, the force must be as the square of the velocity.

The proposition is fully confirmed by Bossut's and Michelotti's experiment; the proportional velocities, with a pressure of 1, 4, and 9 feet, being 2722, 5436, and 8135, instead of 2722, 5444, and 8166; very inconsiderable differences.

There is another mode of considering this proposition, which is a very good approximation. Suppose a very thin cylindrical plate of water, like a wafer, situated in the orifice; and suppose a constant succession of such plates to be put in motion, one at every instant, by means of the pressure of the whole cylinder standing upon it; let all the gravitating force of the column be employed in generating the velocity of each small cylindrical plate, (neglecting the motion of the cylinder itself,) this plate would be urged by a force as much greater than its own weight, as the column is higher than itself, and this through a space shorter in the same proportion than the height of the column. But where the forces are inversely as the spaces described, the final velocities are equal: therefore, the velocity of the water flowing out must be equal to that of a heavy body falling from the height of the head of water.

This velocity may be found very nearly by the rule which we have before given in undershot water-wheels, or by extracting the square root of the depth in feet, and multiplying it by 481.2: the product is the velocity *per* minute in feet.

In practice it is more convenient to take the depth in inches, instead of feet; then to obtain the velocity in feet *per* minute.

Extract the square root of the depth in inches, and multiply it by 138.88: the product is the velocity in feet *per* minute.

As this rule is the foundation of all calculations for velocities, when friction is not considered, it is constantly wanted: we shall, therefore, give a table, calculated by Mr. Smeaton from the above rule, shewing the theoretic velocities corresponding with different depths.

WATER.

A TABLE shewing the Velocity in Feet per Minute, or per Second, with which Water should issue from an Aperture at any given Depth beneath the Surface, from $\frac{1}{4}$ Inch to 20 Feet, calculated according to the Theory of falling Bodies.

Depth.	Velocity per Minute.	Diff.	Velocity per Second.	Diff.	Depth.	Velocity per Minute.	Diff.	Velocity per Second.	D ff.	Depth.	Velocity per Minute.	Diff.	Velocity per Second.	Diff.
Inches.	Feet.		Feet.		Inches.	Feet.		Feet.		Inches.	Feet.		Feet.	
$\frac{1}{4}$	69.7	28.9	1.16	.48	$17\frac{1}{2}$	580.8	8.5	9.68	.14	56	1039.2	9.6	17.32	.16
$\frac{1}{2}$	98.6	21.4	1.64	.36	18	589.3	8.3	9.82	.14	57	1048.8	9.0	17.48	.15
$\frac{3}{4}$	120.0	18.6	2.00	.31	$18\frac{1}{2}$	597.6	7.8	9.96	.13	58	1057.8	9.0	17.63	.15
1	138.6	16.5	2.31	.27	19	605.4	7.8	10.09	.13	59	1066.8	9.3	17.78	.15
$1\frac{1}{4}$	155.1	15.0	2.58	.25	$19\frac{1}{2}$	613.2	7.9	10.22	.13	60	1076.1	26.7	17.93	.15
$1\frac{1}{2}$	170.1	13.7	2.83	.23	20	621.1	7.7	10.35	.13	63	1102.8	25.1	18.38	.45
$1\frac{3}{4}$	183.8	12.4	3.06	.21	$20\frac{1}{2}$	628.8	7.7	10.48	.13	66	1127.9	25.4	18.80	.42
2	196.2	12.0	3.27	.20	21	636.6	7.8	10.61	.13	69	1153.3	25.7	19.22	.42
$2\frac{1}{4}$	208.2	11.4	3.47	.19	$21\frac{1}{2}$	644.4	7.2	10.74	.12	72	1179.0	24.0	19.65	.43
$2\frac{1}{2}$	219.6	10.4	3.66	.18	22	651.6	7.2	10.86	.12	75	1203.0	24.0	20.05	.40
$2\frac{3}{4}$	230.0	10.6	3.84	.17	$22\frac{1}{2}$	658.8	7.3	10.98	.12	78	1227.0	23.4	20.45	.40
3	240.6	9.9	4.01	.16	23	666.1	7.1	11.10	.12	81	1250.4	22.8	20.84	.39
$3\frac{1}{4}$	250.5	9.3	4.17	.16	$23\frac{1}{2}$	673.2	7.3	11.22	.12	84	1273.2	22.8	21.22	.38
$3\frac{1}{2}$	259.8	9.0	4.33	.15	24	680.5	13.7	11.34	.23	87	1296.0	21.9	21.60	.38
$3\frac{3}{4}$	268.8	9.0	4.48	.15	25	694.2	13.8	11.57	.23	90	1317.9	22.0	21.96	.36
4	277.8	8.5	4.63	.14	26	708.0	13.8	11.80	.23	93	1339.9	21.2	22.33	.37
$4\frac{1}{4}$	286.3	8.3	4.77	.14	27	721.8	13.2	12.03	.22	96	1361.1	21.3	22.68	.35
$4\frac{1}{2}$	294.6	7.9	4.91	.13	28	735.0	13.2	12.25	.22	99	1382.4	20.6	23.04	.36
$4\frac{3}{4}$	302.5	7.8	5.04	.13	29	748.2	12.7	12.47	.21	102	1403.0	19.7	23.38	.34
5	310.3	7.8	5.17	.13	30	760.9	12.5	12.68	.21	105	1422.7	21.0	23.71	.33
$5\frac{1}{4}$	318.1	7.7	5.30	.13	31	773.4	12.6	12.89	.21	108	1443.7	19.7	24.06	.35
$5\frac{1}{2}$	325.8	7.2	5.43	.12	32	786.0	12.1	13.10	.20	111	1463.4	19.9	24.39	.33
$5\frac{3}{4}$	333.0	7.2	5.55	.12	33	798.1	11.9	13.30	.20	114	1483.3	19.1	24.72	.33
6	340.2	13.8	5.67	.12	34	810.0	12.0	13.50	.20	117	1502.4	19.4	25.04	.32
$6\frac{1}{2}$	354.0	13.4	5.90	.23	35	822.0	12.0	13.70	.20	120	1521.8	19.4	25.36	.32
7	367.4	13.0	6.12	.22	36	834.0	12.0	13.89	.19	123	1540.8	19.0	25.68	.32
$7\frac{1}{2}$	380.4	12.3	6.34	.22	37	844.8	10.8	14.08	.19	126	1559.4	18.6	25.99	.31
8	392.7	12.3	6.55	.21	38	856.2	11.4	14.27	.19	129	1578.0	18.6	26.30	.31
$8\frac{1}{2}$	405.0	12.0	6.75	.20	39	867.6	11.4	14.46	.19	132	1596.1	18.1	26.60	.30
9	417.0	12.0	6.95	.20	40	878.4	10.8	14.64	.18	135	1614.0	17.9	26.90	.30
$9\frac{1}{2}$	428.4	11.4	7.14	.19	41	889.2	10.8	14.82	.18	138	1632.0	18.0	27.20	.30
10	439.3	10.9	7.32	.18	42	900.0	10.8	15.00	.18	141	1649.4	17.4	27.49	.29
$10\frac{1}{2}$	450.1	10.8	7.50	.18	43	910.8	10.8	15.18	.18	144	1667.1	17.7	27.78	.29
11	460.8	10.7	7.68	.18	44	921.6	10.3	15.36	.17	150	1701.6	34.5	28.36	.58
$11\frac{1}{2}$	471.0	10.2	7.85	.17	45	931.9	10.3	15.53	.17	156	1735.2	33.6	28.92	.56
12	481.2	10.2	8.02	.17	46	942.0	10.1	15.70	.17	162	1768.2	33.0	29.47	.55
$12\frac{1}{2}$	491.4	9.6	8.19	.16	47	952.2	10.2	15.87	.17	168	1800.6	32.4	30.01	.54
13	501.6	9.6	8.35	.16	48	962.4	10.2	16.04	.17	174	1832.5	31.9	30.54	.53
$13\frac{1}{2}$	510.6	9.0	8.51	.16	49	972.6	9.6	16.21	.16	180	1863.8	31.3	31.06	.52
14	519.6	9.0	8.66	.15	50	982.2	9.6	16.37	.16	186	1894.6	30.8	31.58	.52
$14\frac{1}{2}$	529.2	9.6	8.82	.16	51	992.1	9.9	16.53	.16	192	1924.8	30.2	32.08	.50
15	538.3	9.1	8.97	.15	52	1002.0	9.9	16.70	.17	204	1984.5	59.7	33.07	.99
$15\frac{1}{2}$	547.2	8.9	9.12	.15	53	1011.6	9.6	16.86	.16	216	2041.8	57.3	34.03	.96
16	555.6	8.4	9.26	.14	54	1020.8	9.2	17.01	.15	228	2097.6	55.8	34.96	.93
$16\frac{1}{2}$	564.0	8.4	9.40	.14	55	1030.2	9.4	17.17	.16	240	2152.2	54.6	35.87	.91
17	572.6	8.2	9.54	.14			9.0		.15					

WATER.

If we were to calculate the expence or discharge for any orifice by this table, we should in every instance find it much greater than nature really gives us.

It must be recollected, that this table is not calculated from experiment, but from the theory of falling bodies, which makes no allowance for the loss of velocity, which arises from the friction of the particles of water against the edges of the aperture, and against the neighbouring particles of water which are not put in motion.

Sir Isaac Newton, in making experiments, found the velocity thus determined to be too great, which in one case he corrected. The friction against the sides of the aperture, and the oblique direction of the particles of water before they reach the aperture, both tend to diminish the velocity of the stream; and if these causes could be removed, especially the latter, the Newtonian theory would be confirmed by experiment, or rather experiment would exactly agree with theory.

For, if we suppose water running into the top of a cylindrical tube, and that there is no attraction or friction between the particles of water and the interior of the tube, the velocity of the water, or of each of the particles at the bottom, would be the same, or equal to that which they would have acquired in falling through the same space without the tube, towards the earth.

Hence, to obtain the true velocity, under different circumstances, we must correct the computed velocity by experiments.

It is stated in some elementary works on hydrostatics, that the velocity of the water at the orifice is only equal to that which a heavy body would acquire by falling through half the height of the fluid above the orifice. This was first maintained by sir Isaac Newton, who found that the diameter of the stream is contracted, after it has quitted the orifice; and at the smallest part, the diameter was to that of the orifice as 21 to 25. The area, therefore, of the one was to the area of the other as 21^2 to 25^2 , which is nearly the ratio of 1 to the square root of 2. By measuring the quantity of water discharged in a given time, and also the area of the vena contracta, sir Isaac found, that the velocity at the vena contracta was that which was due to the whole altitude of the fluid above the orifice. He, therefore, concluded, that since the velocity of the orifice was to that at the vena contracta as 1 to the square root of 2, the velocity in the vena contracta was that which was due to the whole altitude of the fluid; and that the velocity at the orifice must be that which is due to one half that altitude, because the velocities are as the square roots of the heights. From this, sir Isaac stated the actual velocity of flowing water to be $\frac{707}{1000}$, or .707 of the theoretic velocities.

But the real quantity of the reduction varies in different cases, according to the nature of the aperture: hence, it is necessary to consider all different forms of apertures, and make a different allowance for each case. To do this, the circumstances of the aperture must be carefully examined.

A, fig. 8. Plate II. *Water-works*, explains the manner in which the filaments of water may be supposed to move, when a stream flows through an aperture in a thin plate.

B shews the motion, when a tube of about two diameters in length is added to the orifice, and when the water flows through the tube with a full stream. This does not always happen in so short a pipe, and never in one that is shorter; but the water will frequently detach itself from the sides of the pipe, and flow through it with a contracted jet.

C shews the motion, when the pipe projects into the inside of the vessel. In this case, it is difficult to make the tube flow full.

D represents a mouth-piece fitted to the hole, and formed agreeably to that shape which a jet would assume of itself. In this case all contraction is avoided, because the mouth of this pipe may be considered as the real orifice; and nothing now diminishes the discharge but a trifling friction of the sides.

When water issues through a hole in a thin plate, the lateral columns, pressing into the hole from all sides, cause the issuing filaments to converge to the axis of the jet, and contract its dimensions after it has quitted the hole, and at a little distance from the hole; and it is in this place of greatest contraction that the water acquires that velocity which we assume as equal to that acquired by falling from the surface: therefore, that our computed discharge may best agree with observation, it must be calculated on the supposition that the orifice is diminished to the size of this smallest section. But the contraction is subject to variations, of which the reasons are not apparent.

The following are the measures of the contracted vein, as ascertained by different authors; the area of the aperture being 1000, the area of the contracted vein at the smallest will be as follows:

Sir Isaac Newton	-	-	-	707
Poleni	-	-	-	714
Greatest found by Bossut	-	-	-	667
Mean of six experiments by Bossut	-	-	-	664
Lowest found by Bossut	-	-	-	666
Bernouilli	-	-	-	641
Michelotti	-	-	-	641
Du Buat	-	-	-	666
Venturi	-	-	-	636
Eytelwein	-	-	-	642

The measures given by Bossut were taken by a pair of spherical compasses, with which he measured directly the diameter of the contracted vein, which he found to preserve the same diameter for some lines. The altitude of the water in the reservoir which Bossut used was 12 feet 6 inches. He measured the vena contracta also, when the water issued by vertical orifices placed 4 feet 3 inches below the surface of the fluid, and he obtained the very same results. The ratio between the area of the orifice and the area of the vena contracta appears from the above, to be by no means constant. It undergoes perceptible variations, by varying the form and position of the orifice, the thickness of the plate in which the orifice is made, the form of the vessel, and the velocity of the issuing fluid.

The dimensions of the smallest section of the contracted vein are at all times difficult to be ascertained with precision. It is, therefore, much more convenient to compute from the real dimensions of the orifice, and to correct this computed discharge by means of an actual comparison of the computed and effective discharges, in a series of experiments made in situations resembling those cases which most frequently occur in practice.

We have made a collection of experiments by various authors, and from them we have deduced the following rule for the real velocity with which water issues from an aperture in a thin plate.

Rule.—Measure the depth of the centre of the orifice beneath the surface of the water in the reservoir in inches, extract its square root, and multiply it by the constant number 85.87: the product is the velocity in feet *per* minute.

If the velocity, as marked in the preceding table, is multiplied by .618, the same result will be obtained. For the contraction of the stream or vein of water, running out of a simple orifice in a thin plate, reduces the area of its section,

at the distance of about half its diameter from the orifice, from 1 to .665, according to the mean different statements above quoted: hence the diameter is reduced to .815.

The quantity of water discharged is very nearly, but not quite, sufficient to fill this section with the velocity due, or corresponding to the height. For finding accurately the quantity discharged, the area of the orifice must be supposed to be further diminished to .619 on account of friction.

In regard to the accuracy of this rule, we must refer to the following table, which contains the results of 35 experi-

ments, and also the calculation for each. We have been obliged to reject about 12 other experiments, because they would not accord with the theorem; but in nearly all of them, the velocity was greater than the rule, and those which are less we have preserved. This was done, because we suspect that many of the cases were not apertures in thin plates; but in wood planks of considerable thickness, such as sluices, the discharge would then be greater than our rule supposes, and such cases should be classed with another description of aperture.

TABLE of Experiments on the Efflux of Water from Apertures on thin Plates.

Authors.	Depth in Inches of the Centre of the Orifice beneath the Surface.	Velocity of the effluent Water per Minute in Feet.	Velocity calculated, by multiplying the Square Root of the Depth by 85.87.	Description of the Aperture.
Smeaton and Brindley	12.5	307 +	304	1 inch square.
Boffut	12.8	307 =	307	
Poleni	22.7	381 -	410	2½ circular
Smeaton	24.5	432 +	425	1 inch square.
Defaguliers	25.	432 +	429	1 inch square.
Boffut	25.6	434 =	434	
Venturi	29.3	460 -	464	1 ⁶ / ₁₀ inch square.
	34.	515 +	500	1 ⁷ / ₁₀ inch circular.
	34.6	508 +	505	1½ inch circular.
Boffut	38.4	531 =	532	
Venturi	42.6	553 -	560	1 ⁶ / ₁₀ circular.
Smeaton	48.5	608 +	598	1 inch square.
Boffut	51.2	613 =	615	½ an inch circular.
Smeaton	60.5	680 +	668	1 inch square.
Boffut	64.	685 =	687	
Boffut	76.8	751 =	752	
Michelotti	84.5	790 =	790	3 inches square.
	86.5	807 +	798	1 inch square.
	87.8	805 =	804	3 inches square.
	87.9	803 =	805	
Boffut	89.6	810 =	813	1 inch circular.
	102.5	866 =	869	
	115.	918 =	920	
	128.	967 =	971	
Michelotti	141.	1014 =	1019	3 inches circular
	148.3	1031 =	1045	
	149.2	1035 -	1049	
Boffut	150.	{ 1047 - } 1050 =	1051	3 inches square.
	150.2	1055 =	1053	
Michelotti	275.1	1438 +	1425	1 inch circular.
	276.4	1414 -	1428	1 inch square.
	277.4	1416 -	1430	3 inches circular.
	277.7	1417 -	1431	3 inches square.
	280.1	1404 -	1437	2 inches circular.
	281.6	1446 +	1441	1 inch circular.

These are the results of the discharge through orifices in a thin plate. If we apply to the orifice the shortest cylindrical pipe, that will cause the stream to adhere every where to its sides, we shall find that its length must be twice its diameter. The discharge through such a tube will be about $\frac{1}{2}$ ths of the full quantity, and the velocity may be found by multiplying the full velocities marked in our first Table by .8125.

The greatest diminution of velocity is produced by in-

serting the pipe so as to project within the inside of the reservoir; probably because of the greater interference of the motions of the particles approaching its orifice in all directions: in this case, the velocity is reduced nearly to half of the full velocity.

It was one great aim of the experiments of Michelotti and Boffut to determine the effects of contraction in different cases. Michelotti, after carefully observing the form and dimensions of the natural jet, made various mouth-pieces resembling

fembling it, till he obtained one which produced the smallest diminution of the computed discharge, or till the discharge computed for the area of its smaller end approached the nearest to the effective discharge. And he at last obtained one, which gave a discharge of 983, when the natural discharge would have been 1000. This piece was formed by the revolution of a trochoid round the axis of the jet, and the dimensions were as follow :

$$\begin{array}{r} \text{Diameter of the outer orifice} = 36 \\ \hline \text{inner orifice} = 46 \\ \text{Length of the axis} = 96 \end{array}$$

Eytelwein states that a conical tube, approaching to the figure of the contraction of the stream, procured a discharge equal to .92 of the full velocity; and when its edges were rounded off, of .98, calculating on its least section.

Venturi has asserted, that the discharge of a cylindrical pipe may be increased by the addition of a conical tube at the end of it nearly in the ratio of 5 to 2. (See his experiments in our article DISCHARGE.) But Mr. Eytelwein finds this assertion somewhat too strong, and observes, that

when the pipe is already very long, scarcely any effect is produced by the addition of such a tube. He made a number of experiments with different pipes, where the standard of comparison was the time of filling a given vessel out of a large reservoir, which was not always kept full, because it was difficult to avoid agitation in replenishing it; but this circumstance was rendered indifferent to the results of the experiments by the application of an ingenious theorem. They prove that a compound conical pipe may increase the discharge to twice and a half as much as through a simple orifice, or to more than half as much more as would fill the whole section with the velocity due to the height; but where a considerable length of pipe intervenes, the additional orifice appears to have little or no effect.

The results of the investigations of Bossut, Michelotti, and Eytelwein, agree in a very satisfactory manner respecting the diminution of the discharge in different cases; and we have arranged them in the following Table, which we recommend to engineers, as affording all the necessary information to calculate the discharge from sluices and orifices.

Description of the Aperture through which the Water flows.	Ratio between the real velocity and the theoretic velocity, or that which is due to the whole Depth, as shown by our first Table.	To find the Velocity of the issuing Water.				To find the Number of Cubic Feet of Water which flow per Minute through each Square Inch of the Area.		
		I.		II.		If the Depth is in Feet extract the Square Root and multiply by	If the Depth is in Inches extract the Square Root and multiply by	
		When it is required to know the Velocity in Feet per Second.		When it is required to know the Velocity in Feet per Minute.				
		If the Depth is in Feet multiply by	If the Depth is in Inches multiply by	If the Depth is in Feet multiply by	If the Depth is in Inches multiply by			
For orifices in a thin plate	.618	4.957	1.431	297.45	85.87	2.065	.59633	
For the openings of sluices or apertures in the side or internal walls of the reservoir, without any side walls which can serve to conduct the particles of water in a stream to the aperture	.636	5.1	1.472	306.	88.32	2.125	.6133	
For a short cylindrical pipe from two to four times as long as the bore,	1. When it projects withinside the vessel and does not run with a full bore of water, but in form of a contracted vein within the tube 2. When it projects withinside the vessel but runs with a full bore of water 3. When it does not project withinside of the vessel	.5137	4.119	1.190	247.14	71.40	1.716	.4958
		.681	5.46	1.576	327.6	94.56	2.275	.6566
		.8125	6.515	1.881	390.9	112.86	2.729	.7837
For narrow openings, of which the bottom is on a level with that of the reservoir. Also for smaller openings of sluices, when provided with side walls to conduct the water to the aperture; also for the water-passage under bridges which have square piers with abrupt projections, which do not conduct the water regularly into the passage	.860	6.9	1.992	414.	119.52	2.875	.830	
For wide openings, of which the bottom is on a level with that of the reservoir; also for large sluices with conducting walls in the direction of the stream and for the water-way beneath bridges with pointed piers, which conduct the water into the passage	.960	7.7	2.223	462.	133.38	3.208	.9262	
For a circular orifice or tube formed correspondent to the contracted stream	.983	7.884	2.276	473.04	136.56	3.285	.9483	
For the whole velocity due to the height according to the theorems for falling bodies	1.000	8.019	2.3148	481.14	138.888	3.349	.9645	

To apply these rules for gauging sluices, the following measures must be taken. 1. The perpendicular depth of the bottom of the aperture beneath the surface of the water. 2. The perpendicular depth of the top of the aperture. 3. The horizontal width of the opening. Then, taking the difference between the two first measures leaves the height of the opening.

Note.—If the aperture is not in a vertical plane, but inclined, as is frequently the case in mill-sluices, then the width of the opening must be measured on the slope; but the depths must always be taken perpendicularly beneath the surface of the water.

To make the calculation, find the mean velocity of the effluent water, by calculating the velocity due to the depth of the top of the aperture, and also for the bottom of the aperture, and take a mean of the two.

Note.—When the height of the aperture is less than one-fourth of the whole depth, then the velocity due to the depth of the centre of the aperture will be very near the truth.

Having found the mean velocity in feet, multiply it by the number of square feet in the area of the aperture, and it will give the quantity discharged, in cubic feet.

Example 1.—A sluice, which is four feet wide, is opened or drawn seven inches, and the depth of water above the centre of the orifice is ten feet. The edges of the sluice are cut sharp, so that the borders of the orifice are like a thin plate. What is the velocity and discharge *per* minute in cubic feet?

The square root of 10 is 3.162, which $\times 297.45$ from the table, gives 940.6 feet *per* minute, for the mean velocity of the water.

The area of the aperture is 4 feet, which $\times 7$ inches, $= 28 \div 12 = 2.333$ square feet, for the area of the aperture; therefore, multiply 940.6 by 2.333, and we have 2194 cubic feet *per* minute, for the quantity discharged.

If the depth had been expressed in inches, it would have been 120. The square root of this is 10.95, and this multiplied by 85.87, gives 940.6 feet *per* minute for the velocity, as before. In like manner, the table gives the proper multipliers for finding the velocity in feet *per* second, if it is required.

If it was only required to obtain the quantity discharged, we may proceed more directly, thus. The depth is 10 feet, and the square root is 3.162, \times by 2.065, the number taken from the last column but one of the table, and we have 6.529 cubic feet, which are discharged *per* minute from every square inch of the aperture. The aperture is 48 inches, this $\times 7 = 336$ square inches, this $\times 6.529 = 2194$ cubic feet discharged as before.

If the depth had been 120 inches, then the square root of that number $= 10.95$, and this $\times .5963$, the number in the last column gives 6.529, as the last.

Another method is, to calculate the theoretic discharge, and then make a proper reduction, by multiplying by the decimal number in the first column. Thus, by our first table of velocities, 120 inches deep $= 1521.8$ feet *per* minute, this \times by 2.333 square feet, the area of the aperture gives 3550 cubic feet *per* minute for the theoretic discharge.

The first column of the present table shews that the real discharge is only .618 of the theoretic discharge; therefore, multiply 3550 cubic feet by .618 $= 2194$ cubic feet for the real discharge, as in all the former cases.

This latter method is very convenient, because we can apply a different correction in different cases, according to discretion, and the table of velocities facilitates the calculation very much.

Example 2.—A flour-mill was worked by the water

which ran through a shuttle four feet wide, the depth to the bottom of the aperture was 22 inches, and the shuttle was drawn up one inch and one-quarter, so that the depth to the top of the aperture was 20.75 inches; what is the expenditure *per* minute?

The full velocity due to 22 }
inches depth is by the table } 651.6 feet *per* minute.

Ditto - - - for 20 $\frac{3}{4}$ } 632.7

2) 1284.3

642.15 mean velocity *per* min.

Note.—As 20.75 is not to be found in the table, take 20 $\frac{1}{2}$ $= 628.8$, and add to it half the difference between 20 $\frac{1}{2}$ and 21, *viz.* 3.9 $= 632.7$ feet *per* minute velocity for 20.75, as above.

The area of the aperture 48 inches, $\times 1.25$ inches $= 60$ square inches, $\div 144 = .4166$ square feet. Multiply this by the velocity $= 642.15$ feet, and it gives 267.5 cubic feet *per* minute discharged according to theory.

To reduce this to the practical discharge, multiply by some of the numbers in the first column of the Table opposite, according to the nature of the aperture. The sluice was in a trough, nearly of its own dimensions; so that the bottom and sides nearly corresponded with the aperture; therefore, take .860, and $\times 267.5$ gives 238 cubic feet *per* minute.

It is very convenient to an engineer to be able to calculate the discharge of water by means of the slide-rule. This he may do by means of the two lines usually marked C and D; C being a line of logarithms, and D a line similarly divided on a scale twice as large. By means of these, the square root of any number can be extracted and multiplied by any number at one operation. To use it, find the multiplier which is to be used, upon the line D, and set the slider so that 10 upon C will correspond with it; then seek for the depth upon C, and opposite to it upon D, the required velocity will be found.

Thus,

Line on the slider marked C, depth in inches, 10

Line on the rule marked D, velocity in feet *per* minute, 85.8

And in like manner for any other multipliers: for instance,

Line on the slider marked C, depth in inches 10

Line on the rule marked D, cubic feet *per* minute }
discharged through a } .596
square inch, }

Mr. Eytelwein observes, from Du Buat, that the discharge through an orifice communicating between two reservoirs, and situated beneath the surface of the water in the lower reservoir, is the same as if the water run into the open air, taking the difference of level between the two surfaces, for the depth of the column; he calculates the discharge when the water has to pass through several orifices in the sides of as many reservoirs open above. In such cases, where the orifices are small, the velocity in each may be considered as generated by the difference of the heights in the two contiguous reservoirs; and the square root of the difference will therefore represent the velocity which must be generated in the several orifices, inversely as their respective areas, so that we may calculate from hence the heights of the different reservoirs when the orifices are given. Mr. Eytelwein also considers the case of a lock, which is filled from a canal of

WATER.

an invariable height, and determines the time required, by comparing it with that of a vessel emptying itself by the pressure of the water that it contains, observing, that the motion is retarded in both cases in a similar manner, and he finds the calculation agree sufficiently well with experiments made on a large scale.

Rules for measuring the Quantity of Water which flows over a Weir, or through an Aperture in the Edge of a Board, the Stream being open at Top.—If we suppose water running in a regular sheet over the edge of a large cistern or reservoir, or through a rectangular aperture made in the perpendicular wall or side of the cistern, but open at top, we may take the area of the aperture, and proceed to find the velocity by calculation.

When this subject has been considered theoretically, it has been assumed, that the surface of the water at the place where it runs through the aperture, is without motion, because it stands at the same level with the stagnant water in the reservoir, and that the velocity of the water at different depths will always be as the square root of the depth; that is, beginning at nothing at the surface, the velocity at different depths will increase by that law.

We can find the velocity at the bottom of the aperture, or at any intermediate depth, by the rules and table we have already given; but what we require is the mean velocity of the whole sheet of water. We could obtain this nearly by calculating the velocities for a great number of different depths, increasing by regular intervals, and taking a mean of the whole; but we can effect the same with exactness, if we take two-thirds of the velocity at the bottom, and consider it as the mean velocity of the whole body of water; or, the velocity due to four-ninths of the depth, will give the same result.

In practice we must make allowance for loss of motion by the friction of the water in passing through the aperture, and also because the water does not fill the aperture to the same level as the stagnant water in the reservoir. The motion of the water extends some distance into the reservoir, and the water will consequently have a sloping surface from that part of the surface where the motion begins; the slope will continually increase as the motion of the water accelerates, so as to form a convex surface, which is a portion of a parabolic curve; hence the surface of the water where it is passing through the aperture will be in rapid motion, instead of being motionless as the theory supposes, and the surface will be much lower than the surface of the stagnant water, so that the aperture will only be half full of water; at least this is the assertion of M. Du Buat. But Dr. Robison states, that he always found the depth of the water in the aperture about .715 of the whole depth from the bottom of the aperture to the level of the water in the reservoir.

M. Du Buat's theorem for the discharge through an open aperture, when reduced to English measures, is this: having given the depth from the level surface of the water to the bottom of the aperture, and also the width of the aperture in inches, to find the discharge in cubic inches *per second*.

Let it be remembered that 11.4491 cubic inches of water, or 11.5, will be discharged in a second, through every inch in width of the aperture, when the bottom of it is exactly one inch beneath the level surface of the reservoir. To obtain the discharge for any other depths, this number must be multiplied by the square root of the cube of the depth in inches, and it will give the cubic inches discharged *per second* through each inch in width of the aperture.

Example.—Suppose the depth of the bottom of the aper-

ture beneath the level surface of the water in the reservoir to be 4 inches. The cube of this is 64, the square root of which is 8; therefore, at that depth each inch in width will discharge $8 \times 11.5 = 92$ cubic inches *per second*; if the width of the aperture was 3 feet, then 92×36 inches = 3312 cubic inches, or 1.917 cubic feet, which $\times 60$ seconds = 11.502 cubic feet *per minute*.

Dr. Robison gives the following table, which is rather greater than from the above theorem, and will be found very exact, when the aperture is made in a plank or board half an inch or an inch thick, and so situated that the sides and bottom of the reservoir do not correspond with the edge of the aperture, to lead the particles of water in a current to the aperture.

Depth from the Bottom of the Aperture to the level Surface of the Water, in Inches.	Cubic Feet discharged <i>per Minute</i> through each Inch of the Width of the Aperture.	
	In small Apertures of less than 18 Inches wide.	In larger Apertures than 18 Inches.
1	0.403124	0.428
2	1.140	1.211
3	2.095	2.226
4	3.225	3.427
5	4.507	4.789
6	5.925	6.295
7	7.466	7.933
8	9.122	9.692
9	10.884	11.564
10	12.748	13.535
11	14.707	15.632
12	16.758	17.805
13	18.895	20.076
14	21.117	22.437
15	23.419	24.883
16	25.800	27.413
17	28.258	30.024
18	30.786	32.710

In taking the depth, if it does not exceed four inches, it will not be exact enough to take proportional parts for the fractions of an inch. The following method is exact: if there be odd quarters of an inch, look in the table for as many inches as the depth contains quarters, and take the eighth part of the answer. Thus, for $3\frac{3}{4}$ inches take the eighth part of 23.419, which corresponds to 15 inches. This is 2.927.

If the aperture is not in the side of a large reservoir, but in a running stream, we must augment the discharge, by multiplying the section by the velocity of the stream. But this correction can seldom occur in practice, because in this case the discharge is previously known.

The amount of the allowance for friction and loss of motion must be different in different cases, according to the kind of aperture, or board over which the water flows; but will always be very nearly the same as the allowance, for loss in an aperture or orifice of similar nature. For instance, if the edges of the aperture through which the water runs be a thin plate, then we may find the velocity in feet *per minute* due to the whole depth from the bottom of the notch to the level surface of the water in the reservoir; multiply the square root of the depth in inches by 85.87, as we have

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have before directed, and take two-thirds of the product for the mean velocity; this multiplied by the number of square feet in the area of the section of the aperture, will give the cubic quantity of water which flows *per* minute in cubic feet. Note, in taking the area of the section, we must measure the whole depth from the level surface, and multiply it by the horizontal width of the aperture, and not simply the section of the water. This is because, the theory upon which the rule is founded supposes the water in the aperture to have no velocity at the surface, and to be upon the level of the standing water. Neither of these suppositions is true in reality, but the result is very nearly true, because the section of the moving water is diminished in proportion to the ve-

locity which the water has at the surface, and in consequence the errors of the two assumptions always correct each other.

We have therefore only to apply a correct theorem to obtain the velocity due to the whole depth, according to the nature of the aperture, and take two-thirds of the product. All the necessary information for this purpose may be taken from the table of multipliers last given, for the velocity of the discharge through apertures; or otherwise, if we take the velocity at the bottom, and multiply it by the depth, and take two-thirds of the product, we shall have the mean velocity. But to make the subject clear we shall give another table for this object.

Rules for obtaining the Velocities and Quantities of Water discharged through rectangular Apertures, which are open at Top.

Description of the Aperture.	To find the mean Velocity of the Water running through the Aperture in Feet <i>per</i> Minute.	To find the Number of Cubic Feet discharged <i>per</i> Minute through each Inch in Width of the Aperture.
<i>Note.</i> —The depths are supposed to be measured from the level surface of the water to the bottom of the aperture, in inches.	<i>Rule.</i> —Multiply the Square Root of the Depth in Inches, by some one of the following Numbers, according to the Case.	<i>Rule.</i> —Multiply the Square Root of the Cube of the Depth in Inches, by some One of the following Numbers, according to the Case.
For a small aperture in one side of a large reservoir, the bottom and sides of which do not correspond with the aperture, so as to lead the particles of water thereto in a stream; the edges of the aperture against which the water runs is supposed to be sharp and made of thin plate; the aperture not to exceed 18 inches long and nine inches deep	57.246	.39754
For an aperture under the same circumstances as the former, but made in a plank with edges from half to one inch thick	58.0493	.40312
For an aperture of great breadth and more than nine inches deep, such as the weir or dam in a river; it is supposed that the water runs over the edge of a plank or waste board, one or two inches thick	58.88	.40886
For an aperture of which the bottom is on a level with the bottom of the reservoir, or for a weir which occupies the whole breadth of a river, and where the water flows over the top of a broad stone-wall so sloped as to conduct the water to the passage	88.92	.6174
For the full discharge according to theory, supposing no loss from friction. Very large and deep weirs will come near to this	92.592	.6430

When the aperture occupies nearly or the whole width of the reservoir, there is no level surface of the water above the aperture, because the water is continually running towards the aperture in a stream; such is the case of a weir across a river, or when water spouts out of the open end of a rectangular trough.

It is extremely difficult to measure the exact height of the water above the bottom of the aperture, for the curvature of the surface of the water will begin several feet up the stream before it arrives at the aperture; and there must be something arbitrary in the measurement, because the surface of the water, even where there is no curvature, is not horizontal but sloping, when the water is in motion. In such cases, the depth must be taken beneath the inclined surface of the water, if we suppose the same prolonged until it reaches the aperture, which can easily be done, by stretching

a line along the surface of the water so as to correspond therewith, at the part above where the curvature commences.

We must also make some addition to the discharge, on account of the motion which the water possesses before it comes to the aperture; to do this with accuracy, we may measure the regular velocity of the stream, by throwing in floating bodies, and observing the distance they pass through in a given time, taking care that we make this observation at a part of the channel, where the surface is in a regular motion and not in a state of acceleration, because what we want is the velocity of the water at that point where the curvature begins, in consequence of the descent through the aperture. Now when the channel is not of an uniform breadth and depth, as in a mill-dam for instance, the velocity of every part of the stream is different, we shall then find difficulty in measuring

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measuring the velocity by floating bodies, and must apply the wheel stream-measure before described; this will give the precise velocity of the surface at any given spot, and we should choose that place where the curvature begins. The velocity so obtained we must add to the mean velocity, and find the discharge by multiplying the sum by the area of the aperture.

Example.—Suppose the depth of the bottom of the aperture to be eight inches beneath the line of the surface of the water; that the width of the aperture is four feet, and that the aperture is in a thin plate with sharp edges. Also that the stream is found by the wheel to move with a velocity of thirty feet per minute, at the place where the surface of water begins to deviate from its regular slope, and to assume a curvature.

Then take the numbers 57.246 from the first case in our last table, and multiply it by 2.83, which is the square root of eight (the depth); thus $57.246 \times 2.83 = 162$ feet per minute, for the mean velocity of the water; to this add 30 feet for the previous motion = 192 feet per minute. The area of the aperture is 8 inches, or .66 feet \times 4 feet = 2.66 square feet. Multiply 192 feet velocity by 2.66, and we have 510.72 cubic feet per minute, for the quantity discharged.

Water-Gauge for measuring the Quantity of Water afforded by any Spring or Brook.—The most accurate and convenient method for this purpose, is to construct a temporary bank or dam to intercept the stream, and pen it up into a pond, then in the bank or dam fix a board with an aperture in it for the water to flow through. By measuring the width and depth of the aperture as before explained, the quantity can be calculated by the rules already given.

This is what Mr. Smeaton called the water-gauge, and is of most important use, to ascertain the quantity of water which can be procured to supply a canal, or for a town, or a mill, or any other purpose: it is the necessary prelude for undertaking any such kind of work, and all persons employed in such pursuits, should understand the manner of fixing up a gauge, and making the necessary observations.

The dam must be of such a height as to pen up the water into a tolerable large pond compared with the aperture, so that the surface of water shall have no sensible inclination or run towards the aperture; and to avoid this, the larger the pond is the better. The water must have so much fall down from the aperture, as to flow away in a clear stream perfectly free from all obstruction of the water below; but it should not spout out so as to fall far in the air.

The aperture should be a rectangular notch cut in the edge of a broad plank; it will be best to make the length of the notch some even number of inches, as 6, 8, 12, or 24, and the depth correspondent to the quantity expected to flow through the aperture.

We recommend that the edges of the aperture be cut sharp, or even faced with a slip of metal plate, and then our first rule in the last table will apply with great accuracy. The more common practice is, to use a plank of one inch thick, and leave the edges of the aperture of that thickness, only rounding off the sharp angles: in this case, the second theorem in our table must be used; but this is less certain, because the loss of motion from resistance will not bear a constant portion in different depths, for the thickness of the plank is a constant quantity, and therefore bears a different proportion to the quantity discharged, in every case of a different depth.

The accuracy of our rules, when applied to water-gauges, will appear from the following table.

Results of Thirteen Experiments on the Discharge of Water through an Aperture open at Top, made by Messrs. Smeaton and Brindley, and M. Du Buat.

Depth, in Inches, from the level Surface to the Bottom of the Notch, Inches.	Cubic Feet discharged per Minute, ascertained by Observation,		Cubic Feet discharged per Minute by each Inch in Width, as ascertained by Calculation,	
	the Notch being six Inches wide.	by each Inch in Width.	by the Number .403124.	by the Number .39754.
1.	2.75	.4583	.403	.397
1.25	3.68	.613	.56	.554
1.375	4.07	.678	.646	.64
1.625	5.1	.85	.83	.825
* 1.778	5.75	.958	.958	.94
2.312	8.63	1.438	1.42	1.40
3.125	12.9	2.15	2.22	2.2
* 3.2	13.9	2.316	2.3	2.26
* 4.665	24.4	4.066	4.05	4.90
5.	26.1	4.35	4.5	4.45
5.625	28.5	4.75	5.35	5.30
6.5	40.	6.66	6.7	6.57
* 6.753	42.6	7.083	7.06	7.

The two last columns of the table are deduced from calculation, and agree so well with the observations as to give every confidence in the rules. The last column is calculated on the supposition that the aperture is made in a thin plate; but the last column but one is according to Dr. Robison's number, and agrees more nearly with the truth. We believe that Mr. Smeaton's experiments were made on an aperture in a board one inch thick; the aperture was six inches wide. M. Du Buat's four experiments, denoted by * in the table, were in an aperture $18\frac{1}{2}$ inches wide, which we have reduced to six inches, in order to compare them with Mr. Smeaton's. In making this comparison, we have not rejected any experiment, as we were obliged to do in the case of discharge through the apertures beneath the surface.

Self-registering Water-Gauge.—When the produce of a spring or stream is required with great accuracy, the depth of the water flowing through the gauge must be taken very frequently during a whole season, and a mean of all the results obtained. This would require the constant attendance of an intelligent person, and would be liable to mistakes; but a small machine may be made to shew the depth by inspection, so that any careful person can keep the account. Thus, at the side of the water-gauge, fix up a wooden or tin cylinder or trunk, which is open at the bottom, so that the water can enter freely. In this trunk, or tube, let a float be placed, having a small light rod attached to the float that will rise up from it, and appear above the top of the trunk; this part must be divided into inches and tenths, and must have some index fixed to the trunk to read the divisions by. This apparatus must be carefully adjusted; in the first instance, by the person who fixes the gauge, so that its divisions will correspond with the depth of water measured very exactly in the way we have directed; then the float will ever after rise and fall with the surface of the water, and will shew the depth without any necessity of referring to the original mode of measurement, unless it be to verify the adjustment. It is obvious that such an apparatus must be fixed so, that it cannot be deranged either by design or accident. The tube

in which the float acts should be in the still water some feet above the plank in which the aperture is made, and have a proper box, or cover, which can be locked up, to secure the whole. The float should be a hollow copper ball, or a glass bottle, because wood or cork floats absorb the water, and sink deeper therein; and the rod of wood should be well painted.

A still more perfect water-gauge is obtained by a small machine to keep the register; for this purpose, let an eight-day clock of the ordinary construction be fixed up in a kind of centry-box, or small house, over the gauge; this is to be connected by wheel-work, with a cylindrical barrel, which is to be placed in a perpendicular direction, and made to turn round once in a week by the clock; a sheet of paper is wrapped round the barrel, and fastened upon it in the same manner as paper is fastened on a drawing-board.

The perpendicular stem of the float must have a small pencil attached to it, with a slight spring to cause it to bear against the paper on the circumference of the cylinder, so as to mark upon it: in this way the pencil marks, at a different part of the length of the cylinder whenever the float rises or falls, and the cylinder turning regularly on its axis by means of the clock, causes these risings and fallings to be marked on different parts of the sheet of paper, so that when it is removed from the cylinder it will have a curved line traced upon it, which shews all the increments and decrements of rise and fall, and affords an exact register of the flow of water, which may be reduced to cubic measure, by our rules already given.

A different kind of water-gauge has been proposed by M. De Baader: two large casks or other vessels are to be fixed side by side, in such position, that the stream of water may be poured into either of them by a spout or trough. The spout is so contrived, as to turn the stream into one or other of the vessels at pleasure, with the greatest ease, but the stream cannot run into both at once. In each vessel is a large float which is connected with a perpendicular stem, so that the stem rises or falls with the float, as the vessels fill or empty; also at the bottom of each vessel is a valve, or sluice, to allow the water to run out from it, and the perpendicular stem from the float is provided with means to open this sluice, whenever the vessel is full of water, and the float rises to the top, or to shut the sluice whenever the vessel is empty; and the same action turns the stream of supply from the vessel which is full, into that which is empty. In this way, the two vessels act alternately to receive the water, and measure it, for while the spout runs into one vessel its float rises until the vessel is quite full; the float then turns the spout and stream into the other vessel, which we suppose to be already empty, and at the same moment it will open the valve in the bottom of the full vessel; the water then begins to run out of the full vessel and to fill the other, which becoming full in turn, its float opens the valve in its bottom. In this way the machine continues to measure the water, and is provided with a small counting machine to register the number of reciprocations it has made.

We have now, as far as our limits will allow, given all the most useful and practical rules for measuring flowing water; and shall conclude by observing, that this is one of the most intricate and difficult subjects in hydraulics, and that no engineer can be fully competent to direct the execution of large works without studying the subject much farther than we have been able to enter into it. Many untried cases, and combinations of cases, will continually arise, which cannot be decided by any previous knowledge. As a resource for such occasions, we should be well versed in the theory of the subject, so as to modify the rules laid down for simple cases, and adapt them to his particular case, as far as theory can assist him.

If he only pursues the rules laid down by others, without any knowledge of theory, and without entering into the reason and origin of the rules, his experience will not be of much avail, because he will be unable to correct and improve the rules by his own observations, or if he attempts to do so, he may completely spoil them, by making them false in many cases, in order to obtain truth in some one case.

To attain the knowledge to which we allude, the following authors may be consulted.

Julius Frontinus, *De Aquæductibus urbis Romæ Commentarius*; written about the year 100, in the time of the emperors Nerva and Trajan. This contains all the knowledge of the ancients on this subject. It is printed in *Grævii Thesaurus Antiquitatum Romanorum*, vol. iv. 1630 and 1780. A new edition was also published.

Castelli, a disciple of Galileo, *Della Mefura dell' acque correnti*, 1628.

Toricelli *De Motu Gravium Naturaliter Accelerato*, 1643. In this work we find the origin of the proposition, that the velocities of issuing fluids are as the square roots of the depths.

Raphel Fabrettus de Aquis et Aqueductibus veteris Romæ, 1679.

Marriotte, *Traite du Mouvements des eaux*, 1686. This work contains a great number of experiments on the motion of fluids, and particularly on jets of spouting fluids; but the reasoning is frequently erroneous.

Guglielmini, *La Mefura dell' acque correnti*.—Alfo, *Della Natura dell Fuimi*, Bologna. 1697.

Guglielmini de Fluvii et Castellis Aquarum. These contain a theory which has long since been exploded. He first attempted to apply the principles of falling bodies to the motion of waters in open canals and rivers.

Polenus, *De Motu aquæ Mixto*, Patav. 1697, 1718, 1723. Parent Mem. Acad. Par. 1700.

Newton's *Principia*, 1687. This work contains the doctrine, that the velocity of a spouting fluid is equal to that which a heavy body acquires in falling through half the depth of the column; but which is not correct. And in the second edition, 1713, Newton first points out the contracted vein, and the proportion of its area to that of the orifice to be, as .707 to 1.

Polenus *De Castellis per quæ derivantur fluviorum aquæ*, Padua, 1718. He states the area of the contracted vein to be .571 of the area of the orifice, and he discovered, that more water is yielded by a cylindrical pipe than by a simple orifice.

Michelotti, *De Separatione Fluidorum in Corpore Animale*, 1719.

Dr. Jurin, "On the Motion of running Water," published in the *Philosophical Transactions* for 1718 and 1722. Lowthorp's *Abridgment*, vol. vi. p. 341.

Raccolta De Autori che Trattano dell Moto dell' acque, 3 tom. 4to. Florence, 1723. This most valuable collection contains the writings of Archimedes, Albizi, Galileo, Castelli, Michelini, Borelli, Montanari, Viviani, Cassini, Guglielmini, Grandi, Manfredi, Picard, and Narducci; and an account of the numberless works which have been carried on, in the imbankment of the river Po in Italy.

M. Couplet, *Des Recherches sur le Mouvement des eaux dans les tuyaux de conduit*. *Memoires de l'Acad.* 1732. This is on the motion of water in pipes, and is given by Belidor in his *Arch. Hydraulique*.

Architecture Hydraulique ou l'Art de Conduire d'elever et de ménager les eaux pour les differens besoins de la vie, in 4 vols. 4to. par M. Belidor, *Commissaire Provincial d'Artillerie*, Paris, 1739.

from Comifton and Swanfton, in leaden and iron pipes; but the fupply is very inadequate to the fize of the city.

When water is to be conveyed in an open canal, like the New River, the manner of fetting out and executing the work is fo nearly the fame as for a navigable canal, that it is unneceffary to fay more than we have already given in our article CANAL, except the rules for calculating the neceffary flope or defcent to produce the required velocity of the water; and the beft theorem for this purpofe we have already given in the preceding part of the prefent article.

We fhall only add a few particulars of fome of the largeft modern aqueducts for conveying water.

Aqueduës.—Belidor fates, in his *Architecture Hydraulique*, that one of the fineft fubterraneous aqueducts in France is that of Arcueil, which conducts the water from many collecting channels in a ftone channel. It is fituated in the countries of Rungis, Paret, and Coutin. This aqueduct is 14,920 yards in length, and is conftituted in free-ftone; it extends from the valley d'Arcueil to an elevated water-ciftern, or chateau d'eau, which is at the Porte St. Jaques. The channel has an inclination of 6 inches in 400 yards, or 1 in 2400.

On each fide of the water-courfe is a raifed foot-path 19 inches wide, upon which a perfon can walk as far as the village d'Arcueil. The height of the paffage from the bottom of the water-trough to the under fide of the arch is 6½ feet, except in fome places where they have been obliged to make them lefs, in confequence of the high roads beneath which it paffes.

Another fubterraneous aqueduct of this kind is that of Rocquancourt, which conveys water to Verfailles; it is 3623 yards in length, and in all the length has an inclination of only 3½ feet, which was the utmoft that could be given it. To conftitute this aqueduct, they were obliged in many places to dig to a depth of 30 yards, which rendered the execution of it very difficult. One hundred and fifty shafts were made in the length of this aqueduct. They were not made at equal diftances, but only in fuch places as would facilitate the conveyance of materials; eighty of them were lined with ftone, and the other feventy, which were not required to laft longer than during the conftituteion, were only lined with wood, and ftopped up afterwards with a dome of mafonry, and filled up with earth to the level of the furface.

This aqueduct coft 325,000 livres. From 1675 to 1678 it never yielded more than 6 poudes of water, and fome times gave only 5, 4, 3, or even 2 poudes, according as the dry feafons were of greater or lefs duration. The pouce de fontainier is a meafure of running water ufed by French engineers, which amounts to about .48 Englifh cubic feet per minute; hence the 6 poudes would be 2.88 cubic feet per minute.

A pond was made in 1685 at the head of this aqueduct, to drain a country called Trou d'Enfer; and fince then it has given 10 and 12 poudes, *i. e.* 4.8 and 5.76 cubic feet per minute.

When water is conducted in an open channel, it frequently becomes neceffary to crofs deep valleys; in this cafe, the channel muft be fupported on arches like a bridge. This was the object of thofe vaft Roman aqueducts, of which we find the remains at Nimes, Arles, Frejus, &c. The greateft modern works of this kind are thofe conftituted in the time of Louis XIV. to conduct water to Verfailles and Marly. One of thefe is the aqueduct of Maintenon, for conveying the river Bure to Verfailles: it confifts of three courfes of arches, raifed one above the other, to fupport the water-

courfe, which is a channel of ftone, and on each fide of it is a narrow path with a parapet, which renders it fafe to walk along the fide of the aqueduct when it requires cleaning or repairing.

In the *Philofophical Tranfactions*, it is ftated that this aqueduct is 2560 fathoms in length, and confifts of 242 arches; the fpan of each is 6½ fathoms, and the thicknefs of each pillar to fustain the arches 4 fathoms. On the fide of the valley next to Maintenon, there are thirty-three fingle arches, afterwards feventy-one double ones, (that is, having one arch upon another,) then forty-fix treble ones; at this part the water-courfe is generally 216 feet 6 inches high from the ground up to the floor of the water channel; afterwards there are feventy-two double arches, then twenty fingle ones, which laft reach to a mound of earth, which is raifed 50 feet high above the ground for a great diftance.

The general height from the ground up to the fecond arcade or row of arches is 16 fathoms; from the fecond row to the third or upper arcade 14 fathoms; in the upper arcade, the arches are double the number of thofe they ftand upon; above this is 6 fathoms 6 inches more to the floor of the channel, which is at leaft 7 feet high befides the parapet.

The pillars at the ground are 8 fathoms thick, but with the flopes and fhortenings, which are made in every ftory; the top where the channel runs is reduced to 20 feet broad. There is likewife at each pillar a buttrefs projecting one fathom, and two fathoms wide to ftrengthen the pillars.

There is another great aqueduct raifed on arches in the Plaine de Bue, which conducts water to Verfailles from the Plaine de Scale. This is built with two ranks of arches, and the lower ones are fo much wider than the upper, as to afford room for a carriage-way acrofs the valley about half as high up as the water-courfe. Drawings of thefe great works are given by Belidor.

It is difficult to determine the exact flope which fhould be given to a water-courfe, in order to conduct a given quantity of water; it can only be known by calculation according to the rules we have already given, and which are founded upon experience. Vitruvius recommended a flope of 1 foot fall in 200 feet in length; but Belidor fays this is much more than is neceffary, and that 1 foot fall in 3600 feet of length is quite fufficient, when the channel is ftraight without elbows, or fudden angles, or if the bends at fuch angles are by eafy curves, fo that the water is not retarded in changing its direction. He remarks, that the canal from the pool of Trappes, made by M. Picard to conduct the water to Verfailles, had 9 inches flope in 1000 fathoms, or 1 foot fall in 7998 feet long. When the water was run into this, it took four hours to run 8526 yards, though it was urged by a prefure of 38.3 inches. Alfo that the aqueduct of Rocquancourt before mentioned has only 3 peds fall in all its length, which is 1700 toifes, that is, 1 foot fall in 3400 feet of length. Whence Belidor directs as a general rule to make the fall 1 inch in 100 yards, that is, 1 foot in 3600 feet, provided the bottom of the trough is of fmooth ftone, and not muddy. This is the leaft which can be allowed, and more may be given when the relative levels between the two places will admit of a more rapid defcent.

On the Conveyance of Water in Pipes.—This is an object of great importance. The ancients conducted water in pipes only down hill; but never carried it up again, not knowing that water would rife to its own level; but we can conduct water to very great diftances, and bring it from one mountain to another in pipes, which defcend into the intermediate valleys and rife again, provided that the fpring or place from which

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which the water comes is somewhat higher than the other end where the water is to be delivered. The water would indeed shew itself at the same level at one end of the pipe as at the other, but it would not run out; and in all cases with the same size pipe, the quantity of water given will increase in proportion as the receptacle at the discharge is below the spring at the other end of the pipe. Hence, if there is a great deal of water to be conveyed to a place situated but little lower than the level of the original spring, a very large pipe must be used to convey any given quantity. But the same quantity may be conveyed in a smaller pipe, and consequently at less expence, if the reservoir is much below the original level.

If the distance is great, the length of the pipes will considerably diminish the quantity of water brought through them, in consequence of the friction of the water against the sides of the pipes; this cannot be prevented, and we must make the bore of the pipe larger, in proportion to the length, if the water be in such quantity and so much wanted as to make it worth the expence. The rules for calculating the proper size of pipes we have already given.

Defaguliers mentions an experiment which he made upon a leaden pipe, whose inward diameter was $1\frac{3}{8}$ inch, and found that at 1400 yards distance from the spring of water that supplied it, it did not give a tenth part of the water that it would have given at thirty yards from the spring, though both places were at the same depth below the surface.

All care should be taken in the construction of a conduit-pipe, to avoid obstructions occasioned by lumps of folder hanging in the inside of the pipes, or by roughness at the joints, if the pipes are put together by screw-joints. All the cocks and plugs in the pipe should have water-ways fully equal to the section of the pipe.

Those who execute water-works are most tempted to fail in this point by making the cocks too small, because large cocks are very expensive.

The engineer should be scrupulously attentive to this, for a single contraction of this kind may occasion the extra expence of many hundred pounds in making a large pipe to be thrown away, because if the pipe will yield no more water than can pass through the small cock, it would have been as well to have laid a small pipe all the length.

It is of the most material consequence that there be no contraction in any part of a conduit, and it is also prudent to avoid all unnecessary enlargements; for when a pipe is full of water moving along it, the velocity in every section must be inversely proportional to the area of the section: hence the velocity is diminished wherever the pipe is enlarged; and it must again be increased where the pipe contracts.

This cannot be done without expending force in the acceleration; and consuming part of the impelling power, whether it be that of a column of water, or the force of a machine.

No advantage can be gained by the flow motion which takes place at every enlargement in a pipe; but every contraction, by requiring a restoration of the former velocity, employs a part of the impelling force; this force must be equal to the weight of a column of water whose base is the contracted passage, and whose height is sufficient to produce that velocity with which the water must pass through the contraction.

This point has often been overlooked by engineers of the first eminence; and has, in many instances, impaired the performance of their best works.

Another point, which must be attended to in the conducting of water through pipes is, that the motion of the water should not be by pulsations, but continuous. When the

water is to be driven along a pipe by the strokes of a reciprocating engine, it should first be forced into an air-vessel, that the elasticity of the confined air may preserve an uniform motion along the whole length of pipe. If the water is suffered to rest at every successive stroke of the piston, the whole mass must again be put in motion through all the length of the pipe. This requires a useless expenditure of power, over and above the force which may be necessary for raising or conveying the water to its destination. By employing an air-vessel and double or treble acting pumps we remove this imperfection, because it keeps up the motion in the intervals between the strokes of the piston. The compression of the air by the active stroke of the piston must be such as to continue the impulse during the momentary inactivity of the pump.

Pipes are subject to obstructions from the deposition of sand or mud in the lower parts of the pipes, and from the collection of air in the upper parts of their bendings. The velocity of the water should always be very moderate, and then such depositions of heavy matters are unavoidable; care should therefore be taken to have the water freed from all impurities, before it enters the pipe by proper filtration; and to discharge the sediment which is unavoidable, there ought to be cleansing plugs at the lower parts of the bendings, or rather a very little way beyond them. When these are opened, the water will issue with greater velocity, and carry the depositions with it.

It is much more difficult to get rid of the air which chokes the pipes, by lodging in their upper parts. This air is sometimes taken in along with the water at the reservoir, when the entry of the pipe is too near the surface; but it is easy to avoid this source of the air, by making the water enter the pipe beneath the surface. For if the entry of the pipe is two feet under the surface of the water at the spring, no air can ever get in, and a float may be placed over the entry, with a lid hanging from it to shut the pipe before the water runs too low.

Air is disengaged from spring-water by the motion of the water in passing along the pipe. When pipes are supplied by an engine, air is very often drawn in by the pumps. It is also disengaged from its state of chemical union, when the pumps have a suction-pipe of ten or twelve feet, which is very common. In whatever way it is introduced, it collects in all the upper part of bendings, and accumulates till it will choke the passage, so that scarcely any water will be delivered.

To illustrate this, suppose that the water of a spring, or collection of springs, is to be conveyed through a pipe to the place of delivery, at a mile or half a mile distant from the spring; and that the ground, over which the pipe is carried, has many undulations, and ascents and descents, where it passes over small intermediate hills and valleys. We will suppose the place of declivity to be but a little lower than the water at the spring, for example 9 or 10 feet. If the surface of the water in the spring comes down to the entrance-mouth of the pipe, or only near it, much air will run down with the water into the pipe; and wherever the ground rises in the course of the pipe, this air will lodge itself in the upper parts of the bends of the pipe, and thereby diminish the water-way so as to force the water to pass through a passage of one-fifth or one-sixth, sometimes one-tenth of the proper bore of the pipe when full.

Sometimes, though no air should get into the mouth at the spring, there will be these lodgments of air from the first running of the water; for when the water first enters into the pipe, if after coming down from the spring it has

to rise again, to pass the summit of a small hill, it will run over the eminence without carrying all the air before it, as it had done in other parts of the pipe, before it arrived at such eminence. Hence some air is left in the highest part of the bend, but the water which passes by the air runs forward and fills the pipe again in the descending part, and so goes on in a full bore, till it comes to the next eminence, where it again runs over the highest part of the rising pipe, leaving a space of air at top, which diminishes the water-way. Then filling the pipe full again, it proceeds till its next rising, and there the water-way is again contracted by the air.

To clear the pipe of this air, if the pipe is of lead, the common way, as practised by plumbers, is thus: at every rising ground the pipe is laid bare at the highest place, and a nail is driven into the upper side of the pipe, so as to make a hole through the metal. Whilst the nail is sticking in, the lead is hammered all round the nail, with the pen of the hammer, so as to make a little button or spout. When the nail is withdrawn, the air will blow out violently, till at last the water will succeed the air; and with a stroke or two with the face of the hammer the hole can be quite stopped up.

This is done at every eminence of the pipe, until all the air is discharged, and the full quantity of water will be delivered at the opposite end of the pipe. If the mouth of the pipe at the spring never receives any air, by the descent of the surface of the water, the pipe may give its full quantity for years.

The way to know when the whole water is delivered is to measure it, when the pipe has been fully cleared of air, as above-mentioned; and when by measure, the quantity of water appears to be deficient, the pipe must again be cleared of air or other obstructions.

If the spring is much higher than the place of delivery, the places where the air will accumulate in the pipe will not be just at the highest part of the pipe, but a little beyond it; because the water running with more velocity and force, drives the lodged air still forward down the pipe, and it must lodge in the part where the pipe begins to descend again, its own tendency to ascend to the top being counteracted by the motion of the water. In this case, the nail-hole must be made beyond the greatest elevation, or else the run of the pipe must be stopped for some time, so that the water may cease to be in motion, the air will then go back gradually to the highest part of the pipe, where it may be let out.

Suppose that the water, instead of coming from an elevated spring, be forced up its whole way from a place much lower by an engine, and up the conduit, then the places where the air will lodge will be beyond the eminences of the pipes, but nearer to the upper end. In these cases, it will not be sufficient to prick the pipe with a nail, because air will be continually forced in with the water, and will refill those places in the pipe from which the air had been emptied. The obstructions thus happening often occasion the bursting of the pipe, or it gives too small a quantity of water, and does damage to the engine.

In such a case, the following contrivance must be used; a small leaden pipe, about thirty feet in length, which is called a rider or air-pipe, is laid at the highest part of the main-pipe, and extends along the top thereof. It communicates with the main at the top of the eminence, and also at two other places, at fifteen feet on each side of the eminence. This air-pipe has a little branch and cock. Now if the cock is opened when the engine is working, the air will be pushed forward till it is discharged by the air-pipe and cock. If the air goes beyond the eminence, the pipe of

communication will certainly discharge it. When water comes out at the cock it must be shut, and the main-pipe will then be full of water, but after some time, the cock being left shut, air will gather again in the eminence of the main-pipe and lodge; but, if the air-cock is again opened, the air will be discharged.

When water is forced up by an engine into an elevated cistern, from which it is to run down a main-pipe to the reservoir where it is wanted, this air-cock will also be very necessary, because the water in the cistern sometimes covers the entrance-mouth of the descending pipe, and sometimes not. In that case, air goes down with the water.

In leaden or iron pipes of conduit, the discharge of air is absolutely necessary if there are any rises in the pipe. In wooden pipes the air often passes through the wood and escapes; but if the pipes are tight and thoroughly soaked, the air-pipes and cocks are very useful. When water runs from a raised cistern through a distance of a mile or two, some person should turn the air-cocks two or three times a day.

This trouble may in some cases be avoided, by carrying the air-pipe perpendicularly upwards, to an equal or greater height than the entrance mouth of the main-pipe. In this case, the water will rise up in the air-pipe to near the same level as the water at the entrance, but cannot run over. Nevertheless, if any air passes along the main-pipe, when it arrives at the air-pipe, it will rise up therein in bubbles through the water contained in the perpendicular air-pipe and escape. By taking advantage of some tall building, or large tree to support the perpendicular air-pipe, this expedient may in general be applied.

Defaguliers contrived a valve which should open to let out the air, and shut again when the water came. It was an inverted brass valve shutting upwards, and falling down by its own weight, with cork fixed to the under side of it, to make it rise and shut when the water came. This succeeded in first clearing the pipe of air, but it did not answer to keep it clear; because, when the valve had been shut some time, if air should extricate itself from the water, it would be dense air, whose force would be equal to that of the water, and would keep the valve shut as well as the water did before, although the air at first could not shut the valve. The only remedy for this difficulty is to make the valve very small, and make a hollow copper vessel for a float. This will rise with considerable force to shut the valve, when the water acts upon it; and it will be sufficiently heavy, when the water forsakes it, to pull open the valve.

The same author afterwards made a better contrivance. It is a small square box of cast-iron, made tight on all sides, except where the air-pipe communicates with the bottom of it, and also where a spout is fixed on the top to let out the air. This spout is provided with a cock, situated within side of the box, and to the plug of the cock a small arm or lever is fixed, having a hollow ball of copper at the extremity of the arm or lever. This ball floats on the surface of the water in the box, and when it rises opens the cock, or shuts it when it falls. When the air in the pipe accumulates, it passes along the air-pipe and enters into this box, and as the quantity increases, the surface of the water in the box subsides, until the float at the end of the lever, opens the cock and allows the air to escape, and this it will always do before any air can accumulate in the pipe.

It is best to place the air-box near to the main-pipe, but it must have communication by an air-pipe with the main-pipe, at two or three different places, in order that it may certainly receive all the air which gathers in the great pipe.

On the Discharge of Water by lateral Branch-Pipes from a Main-

Main-Pipe.—It is a common case in water-works, that water is required to be drawn off through a small pipe, from the side of a main-pipe, in which the water is not at rest, but in motion, with a much greater velocity than the flow occasioned by the water which is drawn off through the small pipe. It is often required to know what quantity such small pipe will yield. When water is passing along a pipe, its pressure on the sides of the pipe is diminished in consequence of its velocity; and if a pipe is derived from it, the quantity drawn off must also be less than if the water in the great pipe was motionless. It is therefore of great importance to determine what is the diminution of pressure which arises from the motion along the main-pipe.

It is plain, that if the water suffered no resistance in the main-pipe, its velocity would be that which is due to the height through which it had descended, and it would pass along without exerting any pressure. Also, if the pipe were shut at the end, the pressure within the pipe would be equal to the whole depth of water. Between these limits we shall find what we seek. If the head of water remains the same as when the pipe was stopped, and the end of the tube be contracted, but not stopped entirely, the velocity in the pipe will be small; and the natural velocity due to the descent being checked, the particles will re-act on what obstructs their motion. This action will be uniformly propagated through the fluid in every direction, and will exert pressure on the sides of the pipe. Now obstructions of any kind, arising from friction or any other cause, will produce a diminution of velocity in the pipe. The resistance, therefore, which we ascribe to friction, produces the same lateral pressure which a contraction of the orifice would do, provided that it would diminish the velocity in the pipe, in an equal degree.

We will first consider the case of an horizontal pipe, in which the whole impelling force is applied at one end of the pipe, either by a pump or by a column in a perpendicular pipe at that end. This force must be transmitted or carried by the water through the whole length of the pipe, wherein part of it will be absorbed in overcoming the obstruction and friction, and the remaining force will produce the velocity with which the water issues at the open end of the pipe. It is evident that every part of the horizontal length of such a pipe must bear a different degree of pressure, when the water is in motion; thus, at the end where it is discharged, there is no pressure exerted on the pipe to burst it open, because the water can escape freely; but at every other part a force must be exerted, which is sufficient to overcome all the resistance which the water will meet with, in running from such part to the open end, where it is discharged.

In short, whatever part of the column of water in the reservoir, or of the pressure which impels it along the pipe, is not employed in producing velocity, must be employed in acting against some obstruction; and by the re-action of this obstruction, an equal pressure is transmitted to all parts of the pipe. The chief questions will be, in what part of the pipe are these obstructions situated, and at what part is the force applied which is to overcome them; because that part of the pipe which is between the two, must bear the strain of transmitting the force from the place where it is applied, to the place where it is to operate.

In the case where the impelling force is all applied at one end of the pipe, and the only resistance is the friction of the water in running through the horizontal pipe, the pressure to burst the pipe, will begin at nothing at the open end of the pipe, and regularly increase from that to the other end. Its quantity for 100 feet in length may be ascertained for any given

bore of the pipe, and velocity of the water, from Mr. Smeaton's table of friction already given, and may be adapted to all other lengths by a simple rule of proportion.

If in addition to the resistance by friction, which takes place equally in all parts of the length of the pipe, there are any particular causes of obstruction at the extreme end or at any other part, the force necessary to overcome such resistance must be added to that required to overcome the friction, as found by the table; and all this tends to burst open the pipe, or that part which is between the impelling force and the obstruction, which may arise either from a perpendicular column or lift, up which the water is to be forced, or from a contraction.

Example 1.—A steam-engine with a forcing-pump is employed to force water through a pipe, which proceeds horizontally for 1800 feet, and then rises up 60 feet perpendicular, to a cistern at the top of a tower; the diameter of the pipe is five inches, and the motion of the engine is such, that the water moves with a velocity of 140 feet *per* minute through the pipe. It is necessary to supply a cistern in a house from the middle of the main-pipe, by a small branch-pipe of one inch bore and 100 feet long; this cistern is 55 feet above the great horizontal-pipe, or five feet beneath the elevated cistern; required the velocity with which the water will flow through the small branch-pipe, when the engine is not at work, and when it is at work.

When the water in the great pipe is motionless, there is the pressure of a column of five feet to force the water through the branch-pipe. Mr. Smeaton's table shews, that for one inch bore and 100 feet long, a pressure of five feet, or sixty inches, will produce a velocity of 180 feet *per* minute; but when this pipe is running, the water in the great pipe must move also. The area of the pipe of five inches, is twenty-five times as great as the pipe of one inch; therefore, the motion of the water in the great pipe, will be only one twenty-fifth of 180 feet, or 7.2 feet *per* minute. Find the nearest velocity to this in the table, or ten feet *per* minute, and under five inches bore, we find .07 inches the height necessary to produce that motion, if the pipe was 100 feet long; but as it is 960 feet, the height required will be $.07 \times 9.6 = .672$ of an inch. This should be deducted from the five feet pressure which urges the water through the small pipe; but so small a quantity is not worth notice: hence we may state the velocity when the engine is not at work at 180 feet *per* minute, and the discharge from a bore of one inch, will be .98 of a cubic foot *per* minute.

When the engine is at work, the same pressure will be exerted with the addition of all the pressure necessary to overcome the friction of the water, in running along the great pipe with a velocity of 140 feet *per* minute. Look for this velocity in the table, and for five inches bore it shews, that a column of 7.6 inches must be allowed for every 100 feet of the pipe. The length of the pipe measured from the place where the branch-pipe proceeds to the cistern at the top of the tower, is 900 feet horizontal, and 60 perpendicular, *viz.* 960; therefore, multiply 7.6 by 9.6, and we have 73 inches for the height, which must be added to the five feet, and makes 133 inches for the whole column or force, which urges the water to flow through the branch-pipe, when the engine is at work; lastly, by referring to the table in the column of one inch bore, we find that 135 inches will produce a velocity of 270 feet *per* minute, and the discharge will be 1.47 cubic feet *per* minute.

The same investigation shews us, that the main-pipe at the place where the branch-pipe proceeds from it, must bear the pressure of a column equal to 66 feet one inch when the engine

engine is at work, although it bears only 60 feet when it is at rest. But if we consider the whole length of 1860 feet, the friction will be equal to a column of eleven feet ten inches, so that the pressure, when the engine is at work, will be near 72 feet, at that end of the pipe which joins to the pump.

Example 2.—We will now consider the reverse of this case, that is, take away the pump and steam-engine, and let the water be propelled through the great pipe, by the water descending from the cistern, with a fall of 60 feet. What will be the pressure which causes the water to flow through the small branch-pipe?

To find this, we must calculate with what velocity the water will flow through the whole length of the great pipe, by the theorem and example we have already given for water in pipes. Having found this, calculating on the whole length of the pipe, we must make another calculation, reckoning only as much length of the pipe as is contained between the cistern of supply, and the place where the branch-pipe joins the main-pipe.

Then take the difference between these two velocities, and it shews what resistance or friction the water must overcome in running along the remainder of the pipe, *viz.* from the place where the branch-pipe joins to the open end of the pipe, where the water is discharged. Now if a simple orifice was to be made at that part of the great pipe where the branch-pipe joins, the water would flow out with a velocity equal to the difference of the two velocities, making the proper deduction for the friction of the water in passing through the orifice.

But if we wish to know the velocity with which the water will flow through the branch-pipe, we must find the depth of column necessary to produce the velocity equal to the difference of the velocities of which we have before spoken, calculating according to theory, without regard to friction; and then with the depth so found, we can seek in the table of friction in pipes, for the result or flow of water through the small branch-pipe.

The case of a regularly inclined pipe is considerably different, because the impelling force is not all applied at one end of the pipe; but every portion of the pipe having a descent, has also a portion of the impelling power applied to it. When this pipe is of a certain length, the water arrives as its maximum velocity without accelerating as it proceeds further down the slope; because the accelerating power of the water is in equilibrio with the obstruction, that is, the power of descent acquired in a foot or an inch of the slope, is just equal to the resistance in the same distance; consequently, the water exerts no pressure on the pipe to burst it open, any part of the water would continue to slide down the slope with its uniform velocity, even if it was detached from that water which followed or which preceded, and it derives no impelling power from any column of water. The effect would be just the same, if the pipe was split down the middle and converted into two open troughs.

It is clear, that in this case, no water can be obtained from any lateral branch-pipes, unless they descend from the pipe.

Let us consider the same pipe when the inclination is not a regular slope, but when some parts slope more rapidly than others. In this case, the impelling force is not applied regularly upon every part of the length of the pipe, as in the former instance; the consequence is, that in those parts which have a more rapid slope than the inclination of a line drawn from one end of the pipe to the other, the water will have a tendency to accelerate beyond the regular velocity which is due to the regular slope, and with

which it must ultimately flow out of the pipe; and on the other hand, in places where the slope is less rapid than this line, the tendency of the water will be to flow more slowly than the regular velocity. Now the pipe being close and of an equal bore, the water must flow with the same velocity in every part of the length; and although some portions of the contained water tend to run forwards faster than the regular velocity, yet other portions tend to hang back; by means of the pipe, the force is transmitted from one place to another, and these forces become all combined together to produce an uniform velocity.

We shall find, on farther consideration of these actions, that some parts may be subjected to a pressure or strain to force or burst it open, and other parts may at the same time be strained in an opposite direction, *viz.* to crush the metal of the pipe inwards.

Thus at every point where the pipe suddenly changes its slope or rate of inclination, from an easy slope to a very rapid descent, then the water will have a tendency to run down such sloping part of the pipe, and pass away faster than other water can come down the easy slope; the consequence is, that a suction or aspiration takes place within the pipe, and if a small branch-pipe were applied in such a situation, water may actually be drawn up from a considerable depth. This has been shewn by M. Venturi, who calls it the lateral communication of motion between fluids.

This is a certain proof that the bore of the pipe is too small at such places. An attentive consideration of these circumstances, will shew the propriety of making a long pipe with different bores at different places, where the slope is different; for, by judiciously increasing the bore of the pipe where the slope is less, the action may be made uniform throughout. But this cannot be done in cases where the changes of slope are excessive; for instance, when the pipe descends rapidly into a deep valley, and must rise again with a rapid slope in an opposite direction. This is the case with the pipes which supply Edinburgh, and in many situations is unavoidable.

The resistance arising from friction is greater or less according to the velocity of the motion; but whatever is the inclination of a pipe, provided it is long enough, the velocity with which the water runs through it will so adjust itself, that the sum of all the resistance in the whole length of the pipe, will exactly balance the sum of all the forces, which the water exerts by its descent. But if the pipe is too short, the forces of descent down the pipe may overbalance all the resistances. In this case, the water will tend to accelerate, and the water which has descended near to the bottom of the pipe, will draw after it that water which has just entered the upper part of the slope, instead of the water in the upper part, forcing forwards that water which is beneath it.

Dr. Robison observes that there are some curious circumstances in the mechanism of these motions, which makes a certain length of pipe necessary, for bringing it into the equilibrium of motive force, and resistance, which he calls *train*. A certain portion of the interior surface of the pipe must act in concert in obstructing the motion. We do not completely understand this circumstance, but we can form a pretty distinct notion of its mode of acting. The film of water contiguous to the pipe is withheld by the obstruction of friction, but glides along; the film immediately within this is withheld by the outer film, but glides through it, and thus all the concentric films glide within those around them, similar to the tubes of a telescope, when we draw it out by taking hold of the end of the innermost. Thus the

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second film passes beyond the first or innermost, and becomes the outermost, and rubs along the tube. The third does the same in its turn, and thus the central filaments will at last come to the outside, and sustain their greatest possible obstruction. When this is accomplished, the pipe is in train.

This requires a certain length of pipe which we cannot determine by theory; but it is evident that pipes of greater diameter must require a greater length, and this is probably in proportion to the number of filaments, or as the square of their diameter.

Du Buat found this supposition agree with his experiments. A pipe of one inch in diameter sustained no change of velocity by gradually shortening it, until it was reduced to six feet, and then it discharged a little more water. But a pipe of two inches in diameter gave a sensible augmentation of velocity, when shortened to twenty-five feet; he therefore says, that the squares of the diameter in inches, multiplied by 72, will express the length in inches necessary for putting the water in any pipe in train.

When pipes are of any considerable length, the waters of a larger pipe will run with a greater velocity than those of a smaller pipe having the same slope. A pipe of two inches diameter will give much more water than four pipes of one inch diameter; it will give as much as five and a half of such pipes, or more, because the squares of the discharges are very nearly as the fifth powers of the diameters.

On the requisite Strength for Water-Pipes.—We have shewn that, in certain cases, the water running through a pipe will exert little or no strain to burst the pipes. This may be the case in great portions of the length, or even in the whole length; nevertheless we may observe, that at all parts so situated, an open canal would answer all purposes as well as a close pipe. It is not necessary to employ a close pipe in any case, except where it is subjected to a strain. We may also observe, that it is prudent in all cases to make the pipe sufficiently strong to resist the full pressure of the impelling column, when the motion of the water is stopped; because this may happen accidentally, and then the pipe will burst.

In order to adjust the strength of a pipe to the strain, we may conceive it as consisting of two half cylinders joined by seams, parallel to the axis or length of the pipe; the strength of such seams to resist the separation of the two half cylinders will be equal to the ordinary strength of the materials of which the pipe is made. The inside pressure tends to burst the pipe by tearing open these seams, and the force which acts upon any given length of the pipe (as an inch or a foot), is the weight of a column of water whose base is the diameter of the pipe, by the given length (as an inch or a foot), and whose height reaches up to the surface of the water in the reservoir. This follows from the common principles of hydrostatics, and may be calculated by the rules for columns of water already given.

Suppose the pipe to be of lead, one foot in diameter, what will be the force to burst open one inch in length, at the depth of 100 feet under the surface of the reservoir? Water weighs $62\frac{1}{2}$ pounds per cubic foot, the base of the column is 1 foot by 1 inch, or $\frac{1}{12}$ th of a square foot, and the tendency to burst open an inch long of the pipe is $100 \times$

$$62\frac{1}{2} \times \frac{1}{12} = \frac{6250}{12} = 521 \text{ pounds nearly.}$$

Therefore, an inch long of each seam is strained by $260\frac{1}{2}$ pounds. A rod of cast lead, one inch square, is pulled asunder by 860 pounds. (See *STRENGTH of Materials*.)

Therefore, if the thickness of the seam is $= \frac{260}{860}$ inches, or

one-third of an inch, it will just withstand this strain. But we make it much thicker than this, especially if the pipe leads from an engine which sends the water along it by flarts.

M. Montgolfier states, that a pipe one inch in diameter, and one line in thickness, will bear a column of 50 feet, French measure, from which if we desire to know the proper thickness for any other diameter, with the same pressure, we shall find it by simple proportion. Thus, if the diameter be 4 inches, the thickness must be four lines; or if the pressure is augmented we proceed in the same manner, by direct proportion, so that for 100 feet it must be two lines thick for one inch diameter, and 8 lines thick for 4 inches diameter.

To make full use of this mode of reckoning, he gives the following table of the pressure which pipes of different substances will sustain.

	Feet high.
Copper pipe, 1 inch bore, and 1 line thick, will support a column of water - - -	400
Brass pipe of good quality, and the former dimensions	300
Lead pipe, made of sheet lead - - -	50
Cast-iron pipe, 2 inches bore, and 4 lines thick, will sustain at least - - -	500
Elm wood $1\frac{1}{2}$ inch diameter, and 2 inches thick,	30 or 40

That is, they may safely be made of that size, but will bear sometimes 110 feet pressure.

Lead Pipes.—The plumbers use cast pipes of lead, and also make pipes of tough sheet lead turned up, and burned or melted together in the longitudinal joints; the different lengths of lead pipe are sometimes burned together with lead at the joints, when they are laid in the field, instead of soldering, because this is much cheaper. Leaden pipes may be turned up of any size, but are not usually cast of more than four inches bore. Unless the cast pipes are very found, they are not so good as turned-up pipes; hence it is not advisable to use cast pipes of more than $2\frac{1}{2}$ inches bore. There must be great care taken in making the turned-up pipes, that they may be perfectly cylindrical.

Small lead pipes are made by casting and drawing them through a plate, like wire. See our article PIPES.

The proper thickness for lead pipes, according to Defaguliers, is as follows: a pipe, 7 inches diameter, situated from 140 to 80 feet below the reservoir, must be $\frac{3}{8}$ of an inch thick; that part which is from 80 to 60 feet beneath the reservoir, must be half an inch and an eighth thick; from 60 to 30 feet $\frac{1}{2}$ an inch; and the remainder from 30 feet up to the reservoir $\frac{3}{8}$ of an inch.

For pipes of four inches diameter, half an inch will do from a depth of 200 feet to 100 feet; from 100 to 40 feet depth $\frac{3}{8}$ of an inch thick; and from 40 feet deep up to the reservoir $\frac{1}{4}$ of an inch in thickness.

Defaguliers describes a method of proving the strength of pipes experimentally, by a small forcing-pump, to inject water into a piece of the pipe at one end, whilst a valve is applied to the other, which valve is loaded with such a weight as will equal the weight of the intended column of water; therefore, if the pipe bears this pressure, it will bear the column of water.

Lead pipes are very improper for water-works, where the water is forced by an engine; for at every stroke or push from the engine, the water raises the stop-valve of the pump, and

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and when the valve shuts again, the water falls with it, and gives a sudden blow against all the sides of the pipe. By the lateral pressure, this force acts in a direction perpendicular to the sides of the pipe, with the weight of a pillar of water whose base is the section of the pipe, at the place of the stroke, and the height is equal to the whole height of the water above that place; and it strikes with the same velocity that the valve falls. Now if the first stroke of this water makes the lead swell outwards but the 100th part of an inch, the lead having no elasticity, will remain in that position, and not shrink back; then suppose the next stroke swells the lead outwards the 100th part of an inch more, the diameter of the pipe will become so much larger and remain so. The next stroke will still make it wider, and so on for many strokes, till at last the lead becomes so thin that it must break. This is inevitable if the force is great enough to begin the enlargement, for after every stroke the force of the water striking will be greater than the preceding, in consequence of the enlargement, and will soon burst the pipe. An iron pipe is best to be used, for even if it were in itself as weak as the lead, it would not be liable to be enlarged, although each stroke should make it yield, but by the elasticity of the metal it would return again to its own dimension after every stroke. The same will happen in pipes of copper or wood, because those substances are elastic.

Wood pipes are made of elm or oak, bored through the middle with a succession of augers, increasing in size until the desired bore is attained. Belidor says a man can bore 39 feet of elm pipe, two inches diameter, in a day, but only 6½ feet of oak pipe. The manner of laying and joining pipes is fully explained in our article PIPE.

Care must always be taken that wood pipes are bored in the heart of the wood, and that the heart is of sufficient thickness about the bore of the pipe. Elm pipes of nine inches bore, that are from 80 to 140 feet beneath the surface of the water in the reservoir, must have the heart of elm three inches thick after it is bored: therefore, a tree must be chosen of no less than 18 inches diameter in the smallest part. For a depth from 60 to 80 feet, the heart must be 2½ inches thick, which a tree of 17 inches in diameter will afford; for a depth of from 30 to 60 feet, the heart must be two inches thick, and the tree 16 inches in diameter; and for any height under 30 feet, the heart need be but 1½ inch thick, for which a tree of 14 inches will suffice.

From these proportions it may be determined what thickness the heart of elm should be for pipes of less bore at the same depths, taking it thinner in proportion to the diameter.

Belidor recommends, in laying wooden pipes, to use a composition of mutton fat beaten in a mortar with powder of brick-dust, so as to make a sort of wax. When there are cracks in the wood, small wedges wrapped with tow, and covered with this composition, are to be driven in to stop them.

Earthen Pipes.—M. Belidor states, that the best kinds in France are made at Savigny, near Beauvais; they are in lengths of two feet, which enter three inches into one another, and are made of all diameters, from two to six inches; when the pottery is seven lines thick, they will bear a column of twenty-five feet of water. The joints are made of a composition of pitch, ashes, and brick-dust with mutton fat: this is applied hot; but for larger pipes, a cement of lime is used.

One of the lengths of the pipes for the supply of Edinburgh is made of pottery.

Iron Pipes.—The methods of joining and laying iron pipes will be found in our article PIPE; but we shall give a

TABLE of the Weight of Iron Pipes cast at Carron Iron-Works in 1769, being their Standard for dried Sand Castings, allowing every 36 Cubic Inches of Cast Iron to be equal to 10 lbs.

Diameter of the Infile, or Bore.	Full Diameter of the Flanch.		Length of the Pipe.	Thickness of the Pipe.	Weight of the Pipe.
Inches.	Ft.	In.	F-et.		Cwts. qrs. lbs.
2	0	8	6	1/8 1 1/8 1 1/4 1 1/2 1 3/4 2 2 1/4 2 1/2 2 3/4 3 3 1/4 3 1/2 3 3/4 4	0 2 10
2½	0	8½	6		0 3 4
3	0	9	6		1 0 10
3½	0	9½	6		1 0 27
4	0	11	6		1 1 18
5	0	12	6		1 2 18
6	1	2	8		3 1 21
7	1	3	8		3 3 20
8	1	5	9		6 0 10
9	1	6	9		6 3 4
10	1	7	9		7 1 22
11	1	9	9		9 2 17
12	1	10	9		10 1 12
13	1	11	9		11 0 26
14	2	0	9	11 2 7	

It was afterwards found that, in a long course of practice, it was better to make iron pipes rather thicker; because in moulding there is some uncertainty if the metal is equally thick all round.

WATER, Jets of, fountains were formerly the ornaments of all garden and pleasure-grounds; but are now so far out of fashion, that we only find them in the gardens of the greatest palaces.

The most celebrated are those of Versailles and St. Cloud in France, Frascati, near Rome, and Peterhoff in Russia. The subject of the latter is the contest of Jupiter with the Titans; it contains a column of nine inches diameter, which spouts sixty feet high.

The fountains of Versailles, which are very numerous and magnificent, are fully described by Belidor.

They consist of four grand pieces, which contain excellent bronze statues, representing some subject of the mythology, besides a great number of jets for the ornament of smaller pieces of sculpture. The basin of Latona consists of many jets, which throw up water obliquely 30 feet high, into three large basins, from which it pours down in cascades. The water-piece of Neptune and Amphitrite consists principally of perpendicular jets, which are very numerous. The basin of Apollo contains the god in his chariot, drawn by four horses; the great jets of this piece rise 57 feet, and the smaller jets 47 feet. The baths of Apollo contain most excellent sculpture, and large sheets of water in cascade. There are also the pyramids of water, mountains of water, alleys of water, theatre of water, &c.

We have no room left for treating this subject, which is of some intricacy, and shall conclude with Mr Mariot's table, which shews the altitude of a reservoir necessary to produce a jet of a certain height; and also the quantity necessary to supply jets of a certain-bore, measured in Paris feet and Paris pints, 42.36 of which are equal to a cubic foot English.

WATER.

Altitude of the Jet.	Altitude of the Reservoir.		Quantity of Water discharged in a Minute from an Adjusted six Lines in Diameter.	Diameter of the Conduit-Pipe, suited to the two preceding Columns.
Paris Feet.	Ft.	In.	Paris Pints.	Lines.
5	5	1	32	21
10	10	4	45	26
15	15	9	56	28
20	21	4	65	31
25	27	1	73	33
30	33	0	81	34
35	39	1	88	36
40	45	4	95	37
45	51	9	101	38
50	58	4	108	39
55	65	1	114	40
60	72	0	120	41
65	79	1	125	42
70	86	4	131	43
75	93	9	136	44
80	101	4	142	45
85	109	1	147	46
90	117	0	152	47
95	125	1	158	48
100	133	4	163	49

See our article *JET D'EAU*, Vol. XVIII.

WATER, in *Gardening*, a well known useful article in gardening, as applicable to numerous sorts of young plants and trees, seed-beds, &c., especially in the droughty spring and summer seasons, both such as grow in the full ground and in pots in the open air, as well as those in green-houses, stoves, hot-beds, &c.: and also in ornamental designs, in pleasure-grounds, parks, &c., either when formed into regular pieces, circular, oval, or in oblong or serpentine canals, &c.; likewise when varied in a somewhat natural expanse, in curves and bendings.

In forming designs of this sort, the nature of the supply should be first considered, whether it be by springs in or near the place, by currents or streams passing through, or so nearly adjacent as to admit of being conducted to the place; or by being conducted by some neighbouring river, brook, or lake, &c. by means of pipes or small cuts, or by being collected issuing from higher grounds, and conducted by proper channels. And another circumstance, equally necessary, is to consider the means by which it may be retained afterwards. In a loose earthy, sandy, or gravelly bottom, it will soon sink away, especially in dry weather, unless there is a constant current or flow of water running in; but in a naturally strong clayey bottom, of proper thickness, both at the sides and below, it may be retained in some tolerable degree. In most cases, some art, however, will be necessary in this business. See *BASONS*, &c.

Where it is easily attainable in any of the above modes, it should not be omitted, on a smaller or larger scale, especially in grounds of any considerable extent; but where intended principally as reservoirs for watering gardens, they may be of much more moderate dimensions than when designed for ornament, and may be formed either in a circular manner, an oblong canal, pond, or cut, &c.; the stiffness of these forms being always broken by varying curves of the margins or borders, constantly forming them where the supply of water can be most conveniently procured.

Ornamental plats, or pieces of water in pleasure-grounds,

are very desirable, as being great additions to the beauty, variety, and embellishment of them, when properly disposed and contrasted with some nearly adjoining detached clumps of plantation, and bounded with a proper expanse of grass-ground, spreading from the verge considerably outwards. In general, when any spaces of water, on a larger or smaller scale, are intended, they should be disposed, as conspicuously as possible, in some principal division; either sometimes at or near the termination of a spacious open lawn, or occasionally in some other similar open space; and sometimes disposed more or less internally, in some central or other grand opening; in all of which an expanse of water has a fine effect. The particular forms may be adapted to the nature of the situation, and the extent to that of the supply of water that can be had.

In parks and pleasure-grounds, the most proper situations for plats, or other forms of water, are some rather low convenient places for containing and supplying it, which are so disposed as to display an agreeable rural view of the water from the residences and principal lawns and walks belonging to them, either near at hand, or at some considerable distance from them; and where there are occasionally other accidental sights and views of it, from other parts of the ground, unexpectedly taking place in an abrupt or sudden manner. In these situations the forms and appearances of it may likewise be greatly varied and diversified, according to their particular nature and other concurring circumstances, so as to take off any sort of formal regularity which they may have naturally. They may also have oval, oblong, winding, curving, or bending serpentine directions given to them, as may be the most natural and suitable; and they may be of small or very considerable extents, in proportion to the nature of the situations, and the sizes of the grounds, as well as the supplies of water which can be commanded. They are sometimes in large grounds, formed in the manner of natural bending rivers or streamlets, which sweep round rising swells of land, planted with trees in the form of clumps, or other modes, so as to produce a natural and agreeable effect.

Mr. London, in his ingenious work "On forming, improving, and managing Country Residences," thinks that water, in whatever point of view it may be taken, whether as necessary to the produce of a country, the delight of the traveller, or the interest of romantic rural scenery, is one of the most lovely ornamental materials of nature. Its effects in all these ways are highly useful, interesting, and beautiful; without it all soils are barren and unproductive, roads are dull and uninteresting to the tasteful traveller, and rural scenes are often tame and disgusting. For as it occurs in springy banks, purling rills, or winding brooks, it equally engages and delights; while in the more distant view, in larger expanses, as those of great rivers, glassy lakes, or the extent of the ocean, it exalts and fills the mind with astonishment. And in secluded country scenery it is not less successful in affording variety and pleasure, either by the beauty of its varied appearance, the roar of its fall among rocks and cliffs, the foam and din of it in the small cascade, or the melancholy of it in the stagnant pool, shaded by over-hanging boughs.

But though much has been ingeniously and usefully written on this interesting material of ornamental rural improvement, and the necessity and means of a better taste inculcated in the management of it, little alteration has yet been effected in the modes of practice, as few examples of artificial water rendered picturesque have been set before the public. The former old, naked, tame, shaven, formal methods, still continue to prevail too much in the distribution and

manner of conducting it. There are still not a few, who are infected with

— that strange disease —
Which gives deformity the power to please :

Collections of ornamental water may, it is said, properly be considered as of two kinds; as those designed to be seen in a general view, and in connection with the adjoining scenery; and those to be seen only when near. The former sorts chiefly consist of lakes, rivers, ponds, basons, and others of similar kinds; the latter of springs, rills, rivulets, cascades, and others of the same nature. There are scarcely any situations in which waters of the spring, rivulet, and others of the same nature, may not be placed. In nature, rills are usually found deep sunk in dells, as in instances where they run down the sides of hills, or pass through foils of the sandy kind. Where they pass through a fertile valley, or level meadow, they have commonly a very regular course; and when they are met with in hollow places, their course is for the most part straight, or approaching to it. The situations of rivers, lakes, and ponds, are almost invariably in the lowest parts of the surface of the land. It is, indeed, impossible that they could be otherwise. Water, whenever it occurs, is constantly a striking feature in grounds, and in this way has always its peculiar situation: when that situation is changed, every feature is perverted; truth, nature, and harmony, are set at defiance, and the most glaring discord substituted in their place, striking instances of which present themselves in many different ornamented situations.

The general shape of pieces of water must depend upon the nature of the character which is to be created or given them. Whatever may be the magnitude or dimensions of lakes or ponds, they should be of irregular shapes, more or less wooded, and never entirely naked, being constantly distinguished by prominences and masses; and as often as occasion may serve, further varied by islands managed in a similarity of manner. And the forms and directions of rivers should be given by their sizes, and the nature and kind of country through which they are to pass. Large rivers, in fertile plains, are, for the most part, much less varied in their courses than those of the smaller kind; and both are a great deal less so than those which have their directions through hilly uneven surfaces, or through land of a rocky nature. Large rivers can never be imitated where there does not exist a very considerable stream; as without this, the necessary degree of motion can never be given; but the directions or courses of natural rivers may, it is supposed, be frequently altered, varied, improved, or divided, with the most advantageous effects in the way of ornament; in all which cases the remarks here given will be applicable. Much might be effected in this way at many of the fine ancient seats of this country, and a high degree of grandeur and magnificence of effect be produced.

In regard to the margins or borders of waters, and the accompaniments of them, it is suggested that there are two arguments or reasons, which clearly shew that the former, in every piece of water, whatever may be its character, should be broken and diversified. The first of which is, that thereby intricacy, variety, and harmony in form, colour, and disposition, are produced, in the place of monotony or discord; the second is, that this mode prevails in nature. Intricacy, variety, and harmony, are produced in the outline, by making the small parts irregular, considerably so in some places, and less so in others, according to the kind of water; in the ground by producing breaks close to and also at some distance from the water; by shewing the naked or various-coloured earth and gravel interspersed among

abruptnesses, smooth slopes, levels, and by every form and disposition of surface: it is further heightened by the introduction of stones of different shapes, and placed in varied or intricate disposition; and also by roots, decaying trunks, or branches of trees. It is further suggested, that another fruitful source of these beauties is plants, grasses, low growths, shrubs, and trees. Plants and grasses may, it is supposed, be employed both for cloathing such parts of the surface as are smooth, for varying others, and assisting disposition. Shrubs and trees may be used for the last purpose upon a more enlarged scale. Plants, grasses, and low growths, give intricacy and shade to small breaks, and the interstices among stones, rocks, &c. Shrubs and trees give intricacy to large recesses, either of simple margin, or containing these lesser enrichments, which, shaded by trees, will be heightened in effect. All this, it is supposed, we see accomplished in nature in such a beautiful manner, as far surpasses every sort of description; it may, it is believed, be admired by persons of feeling alone, without much judgment or knowledge of the principles by which it pleases or produces the effect noticed; but this kind of knowledge and judgment is highly useful in directing what to copy from nature, and how to apply it to artificial pieces of water. Without it, persons, it is contended, may argue either for copying the deformities or singularities of nature, or for misapplying them when copied, as has been done by several. There is a difference of character in the margin and accompaniments of a lake, river, and brook, though each is varied or harmonious. Each differs also according to the nature or style of the country, or soil of the land through which they may have to pass, as is evident from a great number of different instances scattered over the country, in which there are particular differences in the banks, adjacent grounds, and accompaniments, that give an interesting variation of character to each individually.

There are some other ornamental appendages which are occasionally placed near to or upon water, such as erections of the bridge, and other kinds. There is no greater ornament to a piece of water of the nature of a river than a bridge, and few objects so generally pleasing, because so universally useful. This notion has been taken advantage of, it is suggested, by improvers, but for the most part in a very injudicious manner. Their bridges are too commonly formal, and unconnected with the scenery, either by their unsuitable magnitude, or by the loftiness of their arches, straddling across a shallow stagnated river, as is the case in many well-known situations. They want, it is contended, that beautiful simplicity, connection, and picturesque effect, which may be seen in many highway bridges across streams or rivers, and which is produced there by necessity and time. Thus the arches, it is said, are made low when the banks on each side are tame and level, because otherwise carts and carriages would have greater difficulty in ascending them. The architecture is simple, because, in general, the builders were not allowed to incur the expence of ornaments. The plants, ivy-bushes, and trees which group with them, have sprung up in the course of time, but they may be speedily imitated by art. The broken parapets, piers, or arches, supplied by open railing, or a few pales, are the effects of time, or accident, and in some cases are worth imitating in the scenery of a residence. These circumstances might easily be copied in ornamental scenery, and if judiciously supplied, it is said, will invariably succeed in producing a good effect. Foot-bridges of planks, or rude boles and trunks of trees, suit well, it is supposed, with many scenes of the rural kind. They have frequently been attempted, it is asserted, but seldom with complete success, owing to the tastelessness of those who contrived them.

The other sorts of erections which have been usually employed for the purpose of *ornamenting* water, it is contended, have rarely either picturesque effect, or any use; such, for instance, as those of aquatic temples, statues, river-gods, and other similar absurdities, or what may be called false decorations. Boat-houses, however, of simple constructions, and for the most part all useful sorts of erections, may occasionally be introduced with propriety and good effect. The Persian-wheel, the forcing-wheel, the corn-mill, and some others of similar kinds, are had recourse to with excellent effects in different places. "The water-wheel and corn-mill at Warwick-castle, it is said, is perhaps the grandest appendage to that noble building; whether in respect to the train of ideas which it awakens in the mind respecting its former compared with its present use, &c., or its effect in connection with the cascade, for which it forms an excellent apology. And though cascades of this kind be formal of themselves, yet the idea of their utility, it is supposed, compensates, in a considerable degree, for the want of picturesque grandeur; and still the *roar* meets the ear through woods, or distance, with the same force as in those which are natural."

Mr. London further supposes, that the picturesque improvement of the pieces of water which already exist will be attended to by all those who at present have artificial waters, in imitation of rivers, lakes, ponds, or brooks, and who are in the habit of making improvements of this kind upon their grounds. Such proprietors may, he thinks, be assured that no part can stand in greater need of alterations than such waters; and should they go on with others, except planting, to the neglect of this, they will not certainly merit the approbation of men of taste, as taste always prefers excellence to quantity. "If, it is said, any proprietor should hesitate to alter a piece of water which he has long been accustomed to see without being sensible perhaps of any great deformity, in consequence of habit, if he looks from his windows to a serpentine river, winding among smooth naked turf, with only here and there a few clumps placed at some distance from its margin; if the water presents one uniform glare of light, clear blue, or dull green, and seldom varied by any shadows or reflections but those of clumps and sky, let him, before he decides in favour of the tame river, imagine that in place of this a broad irregular lake, forming bays and recesses, retiring among thick woods, and with its margin in some places abrupt, broken, and varied by stones, plants, and creepers; in one place smooth, sloping, and covered with grais; and in another clothed with shrubs, trees, and low growths; then let him imagine that he sees these trees, woods, and the different coloured earths and stones of the banks, reflected upon the still surface of the water, which, in some places, was covered with dark shadows from the wood, and in others was bright and clear as the heavens: let him consider how interesting this would appear, even at a distance, and how long he might be employed in tracing with the eye the various recesses, dark places, and reflections; while still much remained indistinct or unseen, and therefore either employed the imagination in completing it according to its own ideas, or awakened curiosity to walk down and examine it minutely, by tracing, as far as could be done without the interruption of thickets and briars, the various windings and intricate margin of the whole. Let him only contrast this with the effect of the piece of water already there, which he can *see* and *know* as completely by a single glance as if he viewed it an hour; and could examine the two extremities, which are all that could be discovered by walking down to it, as completely in a few minutes as if he were to

encompass it a whole day. If the contrast does not strike him, he certainly, it is contended, as far as regards his own taste, is justified in preserving his water as it is; but if otherwise, he ought to commence improvement immediately, not only in gratification of his own sentiments, but also in justice to every attempt to promote and introduce good taste in a country where he is a proprietor, and among a people upon whom he is dependent for his rank and affluence. Different styles of improvement may, it is observed, be ornamental, and admired while they are in fashion; but it is only such as this, which are picturesque, or natural, that can stand the test of time."

The first thing to be considered in the alteration of artificial pieces of water, is the character which ought to be adopted; and the next, the execution of that character in the best manner possible, and with the least expence of labour and money. The former has been already fully noticed, and the latter will be particularly considered below. In many cases, however, the alterations required are so very simple, as to stand in need of little art, either in the designs or the practical parts, as has happened in altering the waters of different fine country-seats.

In short, the management of natural pieces of water, where they come within the province of picturesque improvement, mostly consists in rendering them more characteristic, and by the occasional introduction of *particular effects*. The leading principles in effecting the first of these improvements have been made sufficiently obvious already; and the latter are derived from what takes place in nature; as in the cases of waterfalls, cascades, springs, and drooping banks or rocks, on the margins of large brooks or rivers, all of which may, it is supposed, be imitated in particular instances. Also, in rills and smaller streams there are dank-pools, ponds, and little lakes, which often occur in their courses, that are highly worthy of imitation for their intrinsic beauty, their contrast with the narrow rills, and their use in landscape. Besides, it is suggested that a great advantage of such pools, or little lakes, is, that they may be made to appear natural where no other variety of still water could possibly be attempted. And that, in nature, they are found on the sides of declivities, where they are, for the most part, covered by wood, and seen only on a near view. In level places or situations, or such surfaces as are not strikingly inclined, they are or may be opened in some parts, for the purpose of being seen from distant places in the grounds, as is admirably done in some cases.

Another sort of occasional appearance or effect is *islands*, and they are particularly deserving of imitation, especially in lakes and ponds; nay, even in large rivers or brooks they have often a good effect. In large rivers they are mostly long and narrow; and in brooks frequently so large as to be wholly out of proportion to the stream, containing much extent of surface; but sometimes they are extremely small, and only contain a single bush, a few bushes, trees, or stones and plants; each of which cases may be seen in almost every brook, and they deserve imitation. Islands in ponds, it is supposed, should rather be numerous and near together, than large and distant, and be situated rather approaching the sides than the middle parts: the apparent magnitude of a piece of water may, it is suggested, be greatly heightened from the main point of view, by placing most of the largest islands next the eye, as well as by the mode of planting them. In regard to planting islands in general they should be wooded, but not wholly, and never in such a way as to exclude the appearance of surface, broken ground, rocks, roots, and stones, which

are more natural to islands than to shores, because it must always be supposed that it has been some of these materials which have either occasioned the accumulation of the island, or prevented it from being washed away afterwards.

Waterfalls and cascades are also occasionally introduced in extensive pleasure-grounds, where there is the advantage of a rivulet, by which they may be formed either in one large fall, or in two or three smaller ones in succession, having large rough stones placed below to break the water, and increase the sound of the torrent in its fall and passage over them, in some degree similar to that peculiar to natural cascades. And fountains, spouting water from images, &c. are sometimes introduced in the centre of small or moderate basons, or other reservoirs of water in gardens or grounds, where a supplying head of water is conveniently situated sufficiently high to raise and throw the water from the jet or spout, in a continued full stream, to a considerable height, which falling in the bason, keeps the water of it in motion, prevents stagnation, and is thereby rendered more proper for keeping and breeding fish of the gold and silver kinds, &c. and the spouting and falling of the water have a refreshing effect in the heat of summer. In parterres, shrubby grounds, and particular kinds of gardens, water is introduced either in the forms of still ponds, drooping fountains, or jets d'eau; but as these are all artificial, no perfect mode can be afforded for imitation. They, however, most of them proceed in some measure on the principle of contrast, which, in every modification of matter, is capable of producing either incongruity, variety, or harmony; consequently, of effecting scenes which shall disgust, please, or highly interest the beholder. Jets d'eau are not at present in such disrepute as they were formerly in this country; but they are, for the most part, less understood, and their proper use less comprehended.

Mr. London, in the above work, remarks, that the epithets waterfalls and cascades denote different characters in ornamental improvements. Where the water falls over a ridge of rock in one or more sheets, they are properly denominated waterfalls; and where its fall is broken and interrupted by the irregularity of the ridge, and by other fragments of rocks and stones, they are properly cascades. Both kinds, it is suggested, may be imitated in improved scenery, though hitherto this has seldom been well accomplished, on account either of the restricted practical knowledge of persons of taste, or the limited or vitiated taste, or deficiency of judgment, in those who have had the necessary practical experience in matters of this kind.

However, waterfalls may either, it is supposed, be imitated directly, by being copied from nature, or indirectly, by the introduction of weirs for the use of water-mills, as already hinted. In imitating nature, the strength or durability of the whole must be equally taken into consideration with that of the beauty. The first depends upon the general form of the whole materials, and the second principally on the foundation; but in a partial way also, on the quality of the materials, and the execution. In every case which is upon a large scale, the foundation ought to be the natural rock, if possible; but on a more moderate or small scale, it may be a secure causeway, fixed by oak piles and cross-planks, the work being performed with great care, and in an exact manner; using such mortar, where necessary, as is capable of resisting water.

It is noticed, that there is one variety of waterfall which may be occasionally seen in nature, and which is highly worthy of imitation, though it is not known to have ever yet been attempted to be introduced. It is that where a

small rivulet or rill, at its junction with a river or brook, falls over a rock in one small sheet. It is stated that, "at Matlock Bath, the noise of a small waterfall of this kind forms one of the finest circumstances of the scenery about that place;—borne upon the breeze, its grateful harmony meets the ear in almost every part of the adjacent scenery, in murmurs as varied as their passages through woods and open glades, along the surface of the Dove, under the echoing cliffs of the Tor, or ascending the heights of Abram. This remarkable effect, it is contended, produced by such a small quantity of water, ought to be the greatest encouragement to such as possess brooks or rivulets, as few cases can occur where it may not be imitated; not indeed with such remarkable success, because the surrounding scenery may not be so varied, but still with such an effect as would amply compensate for the expence, which in every case could be but trifling." Others are suggested, and the best manner of forming them clearly explained by drawn figures.

The nature of waterfalls for the purpose of driving machinery are, it is observed, generally pretty well understood; and that as no disguise in the masonry is requisite, but art is commonly to appear, the principles of strength and durability noticed above are what chiefly demand attention. But it is remarked that it is to be regretted that so few who have rivers take advantage of it, and that so many make cascades equally formal and unnatural, without any real use, and with little beauty, either of character in themselves, or fitness and connection with the scenery about them.

As to cascades, what has been said in respect to waterfalls will in general apply. In those which are upon a small scale, and where there is a plentiful supply of water at all seasons of the year, the same forms may be built with similar care in respect to foundation, solidity, and mortar, they being then disguised by rocks of different sizes in a natural manner, in different ways, according to the different circumstances of the places. The same general principles in relation to form will be applicable to all kinds of heads, fish-ponds, &c.; only in these cases the materials are commonly clay or gravel; which last should always be well puddled with clay or stiff loam on the side next the water. In designing waterfalls and cascades, one principal consideration is, it is said, to adapt them properly to the scenery. In some cases, they are quite inadmissible, as in all rivers or brooks without stones or rocks in their beds or margins; and in others where they are few, or where the ground on each side is level, they can never be made of any great magnitude. An attention to nature is, however, sufficient to guide us in this, as well as in every thing else which relates to the subject; a subject which, it is said, is so highly interesting and comprehensive, that it would require a very great space to give a complete elucidation of it in every respect. See *WATER-Falls*.

It may be noticed, that in the business of forming ground for water, the earth must be excavated to a proper depth, gradually sloping from the verge to the middle, from three to four or five feet deep; sometimes, however, in low situations, the place is naturally hollowed in some degree, so as not to require a general excavation, or only in particular parts, and some general regulations to the whole, which in extensive designs is a considerable advantage. Where the sides and bottom are of a sandy, gravelly, or stony nature, or abound in loose soil, and there is not a constant supplying stream, they must be well secured by the application of a thick coat of well-wrought clay. And where this claying is necessary in the preparatory excavation, a proper allowance should be made

made for the additional coat of clay, to the extent of twelve or fifteen inches in thickness, and of several inches of gravel over it, to preserve the clay from being wasted by the motion of the water, and keep it clear, which would otherwise be muddy. But previous to the claying, the loose and uneven parts in the bottom and sides of the cavity should be well rammed, to make the whole firm, even, and smooth; then beginning in the middle space with the clay, and proceeding gradually outward, being careful that no stones, sticks, or other matter, get mixed with it, to occasion fissures, or cracks, by which the water may escape, laying it evenly, a small thickness at a time, and spreading it regularly, treading it well with the naked feet; and if dry weather, casting water on it occasionally, ramming it well from time to time with wooden rammers; then gradually applying more clay, in the same manner, to the proper thickness, being careful that every part is so well puddled and rammed, as not to leave the smallest vacancy. Thus continuing the claying in a regular manner each way, from the bottom to the top of the circumference, smoothing the surface evenly, and in dry weather covering it, as the work proceeds, with mats or straw litter, or with the stratum of pebbly gravel. When the whole is finished, the water should be let in.

When this has been done, the top or verge must be regulated and levelled, forming it evenly from the edge of the water, in a gradual regular expansion to some extent outward, without any stiff slope close to the water, distinct from the surrounding superficies; laying the ground with grass turf, especially along the margin, continuing it as far down as the general level of the water. Where the extent is considerable it may be sown with grass-seeds.

In constructing the excavations for a body of water in such situations as are deficient of materials in some of their parts, as too low in some of their boundaries, as either at the ends or sides sinking below the general surface of the ground, or the height at which the water is intended to stand; these parts must be strongly banked up to the necessary height in a substantial manner, having a sufficient body of proper materials applied, especially where the part is to form a head at the end of a canal, or other similar piece of water; the whole being inwardly faced with a strong body of well puddled clay.

It is well known by every one, the above writer says, that the expence attending the formation of artificial water by the modes which have hitherto been chiefly practised is enormous, and in some instances scarcely supportable; but by adopting improved methods, such as those which have been suggested, it will in almost every case be greatly reduced, and become much cheaper, often to a very remarkable degree. This will be rendered quite evident by considering the different necessary operations in their formation, as they relate to each method of proceeding; such, for instance, as the excavation of the bed for the water, the formation of the head, the spreading of the earth taken out, and the management of the surrounding surface. In regard to the first, the principal reason why it becomes so expensive is, that a river is commonly imitated instead of a lake, which, on account of the natural slope of all grounds, requires not merely larger heads, but a far greater number of them. By in a great measure imitating lakes, one head is, for the most part, all that is required; and this also, many times, of a far smaller dimension than those in the cases of rivers. This alone often makes a very material difference in the cost.

In what relates to the spreading of the excavated earth, and the regulation of the surrounding surface, as in the me-

thods hitherto pursued in landscape gardening, whatever may be the natural character or tendency of the surrounding surface, it is to be reduced, by levelling, to a smooth, even lawn, or pasture, sloping in a gradual manner from the margin of the water. This of course causes a prodigious expence of money; and what is still more disagreeable, it is too frequently quite uncertain, and only capable of being calculated after the finishing of the whole work. The quantity of cubical yards to be removed in the work of excavating can be estimated very nearly to a certainty; but the business of levelling is intricate, troublesome, and often of great extent; hence the great excess of expence which is frequently incurred beyond the estimate in this respect in pieces of made water. If any one plan ever had the advantage over another, it is contended that certainly picturesque or natural pieces of water have the full and complete superiority over those of other kinds in what regards expence. In them, it is maintained, the natural character of the ground is preserved or improved, and consequently no expence of levelling is incurred; the superfluous earth produced in the process of excavating being formed into irregular inequalities, or distributed along the banks in such a manner as to augment or increase their character and picturesque-ness, as is evident in numerous instances. Under other circumstances, vast expence may often be run into, without much, if any, beauty being produced; when it could have been effected to a great extent by the modes which are here advised without laying out much money. Farther information on this very interesting subject may be gained by consulting Mr. London's excellent work.

WATER, Rain, Collecting of, for Farm Use, in Rural Economy, the providing it in proper situations for the purpose. This practice was formerly adopted in different parts of the country: as in most towns, and in the yards, ponds for the use of cattle, are still to be met with, which have an artificial appearance. In extensive pasture heavy or about the houses of many old farm-lands, pools or land districts, pits have evidently been formed by art for the purpose of catching such rain-water as may be brought to them by the ridge-furrows, ditches, or other such means, as well as that of land-springs. The art too has been long practised on the southern chalk-hill parts of the kingdom, and still continues, in a great measure, to prevail; and on those, in some northern districts, it has been more lately established, and spreads itself on the neighbouring heights with vast benefit. It is certainly necessary and useful in all dry high situations. It may probably, in some cases, also be collected into such pits, from the roofs of the buildings, for such purposes, with much advantage; though it has been much too common to draw it up, at great labour and expence, from deep wells formed in the bowels of the earth.

Lately much more attention has been bestowed on this matter than was formerly the case, in most places, and in some with the greatest success and benefit. It should never be neglected where the want of it is considerable, as livestock never do well under such circumstances. See *POND, Made STREAMS,* and *WATERING Live-Stock.*

WATER, Sea, Management of Land gained from, in Agriculture, the bringing ground of this sort into cultivation. It has been observed, that the principal difficulty that can occur in any situation will be to keep off the water of the rivulets or rivers that may come from the surrounding lands, and to carry away and deliver to the sea the surface-water collected from the land gained: the next important consideration is that of clearing this land of surface incumbrances. It will often happen, it is said, that the ground

to be defended is intersected by a river. This is, it is thought, the most expensive and difficult case that can occur; but it is here only necessary to carry the defence along each side of it to the sea; and there, where it intersects the other line of defence, to place a flood-gate, which may prevent the tide from entering, except when it may be necessary to admit vessels or other things, and which shall allow the water of the river to pass into the sea. Small rivulets and springs may either be turned along the margin of the land gained, and be let out at one end of the defence where it joins the land, or be led the most convenient way to one or more of the valves or flood-gates, which it is necessary to make in all defences for excluding the water within. The water collected on the surface of the land gained, may generally be let off by the above flood-gates or valves; but where the defence is extended into the water, this cannot be the case, as the level of the sea will mostly be above that of the land. In this case, wind-mills for driving pumps must be placed at proper distances, according as the particular case may be. Perhaps, in general, one small wind-mill driving four pumps, may be sufficient for freeing a thousand acres of ground of water. The expence of such a pump-mill would not, it is said, be above twenty or thirty pounds. By making a small defence-bank, from two to four feet high, some distance within the larger one, all the water collected between that and the original shore would be accumulated; and it might be led in a raised canal in the same level to a flood-gate in the outer defence. This would, it is thought, leave very little water to be drawn up by the pump; and in this way, though twenty thousand acres were gained, one wind-mill only would be necessary. Often, and indeed in most cases, in place of a wind-mill, the brooks, rivulets, or springs collected within, might easily, it is said, be made to turn a water-wheel, which would be more permanent and uniform than that turned by the wind. A basin might also be constructed, so that the ebb and flow of the tide would turn a draining-wheel; and a great many other methods might, it is supposed, be successfully adopted. Thus, in land gained from the sea, there cannot, it is thought, be any difficulty in preserving it from water, from whatever quarter it may come. When the land to be gained is more or less covered with stones, these should be put in flat-bottomed boats at low water; and when the tide floats them, they should be rowed to the proposed line of bank defence, and be then dropped. This mode of conveyance will generally be found the most economical for all the solid materials which are at a distance. Where the ground is sandy or poor on the surface, and argillaceous earth or rich loam below, it may be trench-ploughed to such a depth, as to turn up the good and bury the bad soil. If the soil be shallow, and even rocky, it may still, it is said, be rendered valuable. The most rocky parts may be covered five or six inches deep with mouldy matters, and the whole be sown with either meadow grass-seeds, to be floated with fresh water, or kept as meadow; or with other proper and suitable grass-seeds, and kept as salt-marsh. When mud of a good quality and considerable depth is gained, it may, in some cases, it is thought, be desirable to summer-fallow it for one or more seasons, after it has been secured from the sea. At other times it may be better to sow it with rape-seed for the first season, and to summer-fallow it the next, as a preparation for a corn-crop, &c.

It is observed that no sort of land can be gained from the sea but what is of great value for the purpose of cultivation, and especially as it can for the most part be flooded by fresh water as well as by that of the sea at all times. By flooding, the most barren sand or rock, with only an inch or

two of soil upon it, will bear excellent pasture. Indeed, much of the sand in these situations that is often reckoned barren and useless, is mixed with broken shells, and on being examined will be found to contain three or four parts in ten of calcareous matter. Most of the large rocks, too, within the salt-water mark are, it is said, in a state of rapid decomposition, and so fragile on the surface, as to be easily penetrated by the roots of grass-plants; more particularly after they have been exposed for some length of time to the action of the atmosphere. The large detached stones often found within the water-mark are not here meant, as these are supposed to be either buried in the ground, or boated off as above; but those continued rocks which frequently constitute the basis of the sea-shore for great distances, the surface of which is so completely oxydated, and occasionally decomposed and reduced so as to be called *rotten*, that they are capable of affording either an excellent manure for certain soils, or are fit and proper for supporting the vegetation of saline plants in their actual condition.

The quantity of land of this sort that is easily capable of being obtained and thus cultivated is very considerable indeed, perhaps not less than some millions of acres in the whole island. See *WASTE Land*, and *WATERING Land*. Also *SALT-Marsh*.

WATER, Gum. See *MUCILAGE*.

WATER, Hungary. See *HUNGARY Water*.

WATER, Laurel. See *LAUREL*.

WATER, Lime, is common water, in which quicklime has been slaked. See *LIME-Water*.

WATERS, Ophthalmic, or Eye, are such as are good in disorders of the eyes. See *COLLYRIUM, EYE, and OPHTHALMIA*.

WATER, Tar. See *TAR-Water*.

WATER, in Anatomy, &c. is applied to divers liquors, or humours, in the human body.

Such is the *aqua pblegmatica*, plegmatic water; which is a ferous fluid contained in the pericardium.

WATER, in Geography and Hydrography, is a common, or general name, applied to all liquid transparent bodies, flowing on the earth.

In this sense, water and earth are said to constitute our terraqueous globe.

Some authors have rashly and injuriously taxed the distribution of water and earth in our globe as unartful, and not well proportioned; supposing that the water takes up too much room.

The quantity of water on this side our globe, Dr. Cheyne suspects to be daily decreasing; some part thereof "being continually turned into animal, vegetable, metalline, or mineral substances; which are not easily dissolved again into their component parts." *Philosoph. Princip. of Relig.*

Many modern philosophers are of the same opinion.

An inundation, or overflowing of the waters, makes a *Deluge*; which see.

WATER, among Jewellers, is properly the colour or lustre of diamonds and pearls; thus called, by reason these were anciently supposed to be formed, or concreted of water. The term is sometimes also used, though less properly, for the colour or hue of other precious stones.

WATER is also used in divers ceremonies, both civil and religious. Such are the *baptismal water, holy water, &c.*

WATER, Holy, is a water prepared every Sunday in the Romish church, with divers prayers, exorcisms, &c. used by the people to cross themselves with at their entrance, and going out of church; and pretended to have the virtue of washing away venial sins, driving away devils, preserving from

WATER.

from thunder, dissolving charms, securing from, or curing diseases, &c.

The use of holy water appears to be of a pretty ancient standing in the church: witness St. Jerom, in his life of St. Hilarion, and Gretser, de Benedict. cap. x. &c.—M. Godeau attributes its original to Alexander, a martyr under the emperor Adrian.

Many of the reformed take the use of holy water to have been borrowed from the lustral water of the ancient Romans: though it might as well be taken from the sprinkling in use among the Jews. See Numbers, xix. 17.

Urban Godfrey Siber, a German, has a dissertation, printed at Leipsic, to shew, by proofs brought from church history, that one may give holy water to drink to brutes.

Bitter Waters of Jealousy.—In the Levitical law, we find mention made of a water, which served to prove whether or no a woman were an adulteress. The formula was this: the priest, offering her the holy water, denounced, "If thou hast gone aside to another, instead of thy husband, and if thou be defiled, &c. the Lord make thee a curse and an oath among thy people, by making thy thigh to rot, and thy belly to swell; and this water shall go into thy bowels, to make thy belly to swell, and thy thigh to rot." And the woman shall say, *Amen.* "These curses the priest shall write in a book, and blot them out with the bitter water. When he hath made her drink the bitter water, it shall come to pass, that, if she be defiled, the water shall enter into her, and become bitter, and her belly shall swell," &c. If he be not defiled, she shall be free, and conceive seed." Numbers, chap. v.

WATER, Interdiction of Fire and. See INTERDICTION.

WATER of Flax and Hemp, &c. that which is used for steeping or raising them in, in the view of procuring the pure vegetable fibrous matters that they contain. The writer of the "Elements of Agricultural Chemistry" has observed, that this water possesses considerable fertilizing powers. It appears, it is said, to contain a substance analogous to albumen, as well as much vegetable extractive matter. It putrefies very readily. And that as a certain degree of fermentation is absolutely necessary for obtaining the matters of the flax and hemp in a proper state; the water to which they have been exposed should on that account be used as a manure as soon as the vegetable fibres removed from it.

WATER, Black, a disease in neat cattle and sheep, which is not unfrequently of a serious nature. It has not, however, been yet properly or fully investigated.

In neat cattle it is said to arise from sudden changes in the state of the weather from heat to great cold, the taking of cold on being turned into low wet pastures in the early spring season, and the want of proper water in long dry times. Some suppose too that it may be caused by fresh pastures of particular sorts, and that certain vegetables picked up by the cattle may produce it. It consists of a discharge of a dark black bloody nature from the kidneys, and sometimes probably from other parts of the body. It is most probably produced by inflammation terminating suddenly in a state of great debility and relaxation of the parts, so as to admit the dark grumous blood thrown out to pass away in this manner.

In slight cases of this nature the cattle do not seem to be greatly affected by the disease, but where the bloody fluid passed away is considerable, and lasts for some length of time, the animals become reduced to a very low state or condition, and great weakness is the consequence, which if not speedily removed by some proper remedy, the cattle soon sink under the pressure of the complaint.

In the cure, except the disease be taken at its commencement, bleeding will seldom be useful or necessary, but the bowels should be well cleared out by powerful evacuating remedies of the salt kind, and kept properly open by their repetition, so that the cattle do not become in the least constipated, which would be hurtful and dangerous. When the discharge continues, balls composed of alum, rust of iron, and armenian bole, made up with Venice turpentine, may often be of service, when given in sufficient quantities; but a more powerful and effectual remedy will be found in a strong decoction or infusion of bark, with vitriolic acid, and the tincture of opium, given in the proportion of a pint of the first, two drachms of the second, and three drachms of the last. This may be repeated once or twice in the course of the day where necessary, the bowels being always well kept open.

By some of these means the disease may mostly be removed without any great difficulty.

Some think that much benefit often arises from the use of nitre in full doses in this disorder, as well as from the change of pasture, in some instances, as from low to such as are rather high in their situation.

In *sheep* the disease is characterized by much the same appearances, taking place suddenly, most commonly among those of the hog kind, and such as are apparently strong, while feeding in rank pastures of the clover or other luxuriant grass kinds. In these cases, there is sometimes much dark bloody watery fluid met with in the stomachs of the sheep after death. The disease in these animals is mostly very rapid in its progress, therefore the sheep in such pastures should be constantly well looked to, in order to discover if any of them be indisposed.

In the prevention of the black water in these animals, some have found great benefit by the use of about half a tea-spoonful of sulphuric or vitriolic acid in mixture with a small spoonful of the compound tincture of cinnamon, when given in a cup of cold water to each sheep in the morning, and cotting or housing them in the night season.

In other cases, when the disease appeared to be present, much advantage has been said to be produced by giving a strong infusion of oak-bark with aromatics, well acidulated with the sulphuric acid, and to which has been added a little of the tincture of opium. The bowels are to be kept in an open state at the same time.

The immediate removal of the sheep into closer fed and drier pastures, will always be attended with great benefit in this disease, and the supplying them with dry food might perhaps in some cases be of utility.

WATER, White, a name often given to a dangerous disease in sheep.

WATER in the Head, a denomination frequently applied to a disease in the head of sheep. See GID and STURDY.

WATER Braxy, among *Animals,* a disease in sheep, which has been disputed by some; but which the writer of the "Shepherd's Guide" is confident exists, having seen and dissected several cases of it after death; and is assured, too, that it does considerable damage on some particular farms, in some situations; but that whether it be a species of the common braxy or not, will, it is thought, admit of a doubt, though it is always viewed and considered by the shepherd as such. It is stated in addition also, that in two external appearances it has a resemblance to it. The first of which is, that the animal, when living, seems affected much in the same way, lying frequently down, and loitering behind the rest of the flock, appearing likewise somewhat swelled in the body. And that the next is, that, like all others affected with the braxy of any kind, it will not bleed

to any extent on opening a vein. The cutting of a vein in the tail, spould, or below the eye, will make other sheep bleed plentifully; but from these scarcely a drop will issue; and even on cutting the principal vein in the throat, only a very small quantity, it is said, proceeds to flow out.

However, in the interior appearances it differs very widely and materially. On opening the sheep, the whole entrails are, it is observed, swimming in bloody water, none of which is within the bowels, but only within the rim of the belly. The gall-bladder is very small, appearing as having been mostly spilled previously to the death of the animal, and the urinal bladder is contracted and shrunk up to a size scarcely noticeable. The small fibres connecting it with the other parts are inflamed, and on bringing it near the nose smells somewhat like the other braxy. The bladder seems entirely without urine, but on blowing it up it is always quite sound, and never bursts; the guts and flesh are a little discoloured, and have a smell peculiar to that disorder. The smaller department of the stomach or *reid* has some purple spots on it; and, on being felt with the finger, these are thicker in the texture than the other parts of it. They seem, too, to have bled a portion inwardly; this some suppose issues from the liver.

In an essay inserted in the appendix to the Rev. Mr. Findlater's Account of the Agriculture of the County of Peebles in Scotland, it is said to be a disease that is analogous to the suppression of urine, which is caused by the want of sufficient activity and exertion. And that it consists in the bladder being over-distended with urine, which raises violent inflammation in that organ, and produces an incapacity to discharge the urine that is accumulated. The consequence of which is, that the urine regurgitates over the body; the whole carcass is tainted by fetid gases; the bladder becomes gangrenous, bursts, and the animal dies. That young and vigorous sheep are most liable to this sort of braxy. And that the immediate cause of the disease is feeding too freely on rich succulent diuretic food, and resting too long in the morning on the layers, taking place frequently when the shepherds are more negligent than usual in removing them.

It is supposed that the disease may be prevented by avoiding too free an use of succulent diuretic food, and by moving the animals from the layers on which they are early in the morning, making them walk about for some time in the view of encouraging them to pass their urine and purr.

In attempting the cure, in case the bladder be greatly distended and affected, which may be known by there being a great fulness in the lower part of the belly, the urine may be endeavoured to be drawn off by the introduction of suitable implements of the catheter kind, or by cautiously letting it off by incision or puncture, where that cannot be done. In either of these ways, when effected, great relief will be afforded.

And in the view of allaying or preventing inflammation, the use of proper purging and evacuating injections should be had recourse to, such as Glauber, or other salts of the same kind; or even warm milk and water be thrown up.

The first writer, however, thinks that no remedy for the disease has yet been pointed out that can be fully depended upon. See BRAXY, and STRIKING *Ill, Blood, or Sickness*.

WATER Farcy, a disease in horses of the œdematous or partial dropical kind, which is often very troublesome in its removal. It has no relation or resemblance, however, to that of the real farcy, being wholly different in its nature, causes, and effects, though sometimes ignorantly supposed

to be of the same kind. It occurs in horses of all kinds and descriptions, and at most periods of their existence. It is a soft watery swelling below the skin, and is caused by whatever has a tendency to weaken and destroy the natural vigour and strength of the body, whether in a local or general manner, but more especially in the former, such as low bad keep, want of sufficient cleaning and dressing, taking the animals into cold water in a warm state, too great exposure to cold rains, and many others. It often, too, happens after severe colds of the epidemical kind. The swellings take place in different parts, but particularly in the legs, having a pitted or dimpled appearance when pressed by the finger. In some cases, the disease has a more general dropical aspect, the water not being confined to any one part, but shews itself in several, over the whole body, by such swellings. These cases, for the most part, proceed from foul feeding, or the effects of eating too greedily of rich luxuriant after-grass. In the former case, the limbs and the whole body are sometimes seen enormously swelled, and become very hard, the belly and sheath parts being very greatly distended.

In the cure of the disease, in all the cases, the great objects are the removal and discharge of the water, and the prevention of its future formation by every possible means. The former are to be attempted by the giving of strong diuretic purgative remedies, and the latter by the use of medicines of the strengthening kind, so as to brace up and restore the tone of the relaxed solids of the whole body.

In the first of the above intentions; the combining of calomel and squills with jalap and aloe, in the proportions of about one drachm each of the two first, to two drachms each of the two last, for a large horse, may be very useful, when made into a ball, and given every night, or every other night for four or five times, and repeated as there may be occasion; throwing in, in the intervals, bark and other tonics, in full quantities, to restore and keep up the strength of the animals.

Rather strong infusions of the fox-glove with aromatics may likewise be tried, and oak-bark in powder, with the same, be given in large doses at the same time they are made use of.

The horses should frequently, too, have good mashes in which nitre has been put.

Gibson, however, advises the horses to be purged once or twice in ten days, and to have intermediately a pint night and morning of the strong decoction or infusion of black hellebore, prepared by boiling or infusing it in water, and then adding to four parts of it two of white wine, that has stood upon the same for some length of time in a warm state; or a ball composed of nitre, squills, and camphor, in the quantities of two drachms of the first, three drachms of the second, and one drachm of the third, made up with honey, and given once a day, either alone, or washed down with a hornful or two of the above infusion.

The horses should be kept warm, and have plenty of dry food while they are under these courses of medicine. See FARCIN.

WATER Sickness, a disease among sheep of the dropical kind. It is a disorder, or sort of affection, arising in the weak states of their constitutions, which is incident to all the varieties of soil and climate, it is said, in its different forms and degrees of violence, from Shetland in the north of Scotland, to the most southern parts of this country, wherever sheep-husbandry is carried on. It is observed to occur, in general, among aged sheep, that are subjected to its attacks in consequence of weakness, either of the more general or more local kind. It most commonly seizes the animals towards

the end of the harvest-season and winter, and on farms which are mostly destitute of shelter. It is, in fact, said to be the genuine offspring of cold and moisture, and perhaps of every thing that debilitates the vigour of the animals.

The appearances that distinguish it to be present are swellings in the legs towards night, which disappear in the morning, when the lower jaw often becomes a good deal swelled. The eyes are dull, the urine, when noticed, is high coloured, the tongue is dry, and as the disease advances, the belly often becomes tense, and water is felt undulating in it, especially on being struck on one side with one hand, while the other is kept steady on the other side. The sheep lose their heart and vivacity, their appetites fail them, they become thin and lean, and at last fall away and die.

In regard to the prevention of the disease, a dry well-sheltered sheep-walk is said to be good in that intention; and the neighbourhoods of sea-shores are useful in the same view, as have been found by experience. But if the distemper should shew itself in a severe manner, in very wet seasons, in winter or spring, night-shelter is found of particular benefit in stopping the increasing state of the malady. The animals, too, should have good, green, sweet, dry hay chopped and given them, at the same time with a little oats or bran in some cases.

In the cure of those which are diseased, a shed or room in a house, and a full allowance of the same sorts of dry food, are particularly necessary and useful. Some have tried tapping in the advanced stage of the disorder, but with only a temporary relief. Two drachms of cream of tartar given twice a day, in a little warm thin oatmeal-gruel, have been known to have a remarkably good effect. In the more early stages of the complaint, small quantities of calomel with squills would probably remove the disease, especially if accompanied with a few hornfuls of a strong decoction of oak-bark two or three times a week. By these means, diseased sheep, when taken early, would perhaps be readily restored.

In the above-named part of Scotland, the disease is said to be called by the title of shell-sickness, as well as that which is here given it.

WATER-Calamint, in *Botany*, the name used by some for a species of mint. See MENTHA.

WATER-Crowfoot, in *Agriculture*, the name of a plant of the weed kind, on which cows are said by some to be very fond of feeding. And in the fifth volume of the Transactions of the Linnean Society, Dr. Pulteney has observed that it is not only relished by swine, but that they thrive remarkably upon it, requiring little or other food until put up to fatten. The produce of it cannot, however, be great, so that the use of it must be limited.

WATER-Cress, in *Gardening*, the common name of a small creeping plant of the herb kind growing in watery situations, such as the sides of rivulets, rills, brooks, or other small trickling streams; and which is much employed as a salad herb, and for eating with bread and butter, or in other modes in its natural state, as being highly cooling and agreeably bitter. See CRESS.

WATER-Dropwort. See DROP-WORT.

WATER-Germander. See GERMANDER.

WATER-Hair-grass. See AIRA AQUATICA.

WATER-Hemp-Agrimony. See WATER-HEMP-AGRIMONY.

WATER-Leaf. See LEAF.

WATER-Lily. See NYMPHÆA.

WATER-Melon, the vulgar name of a plant of the melon kind, growing in aquatic situations, and the fruit of which is of a watery insipid nature. See CUCURBITA CITRULLUS.

WATER-Parfnep. See PARSNEP.

WATER-Poa. See POA AQUATICA.

WATER-Soldier, a species of *Stratiotes*; which see.

WATER-Tath, in *Sheep Husbandry*, a term applied to that sort of rank grass that arises from an excess of wetness in sheep-walks and pastures, and which has a tendency to produce the rot in these animals. It may be caused by too much wetness in the lands, either naturally, or by the use of water on them. It is this probably that makes water-meadows so dangerous for sheep at certain periods. See TATH and WATER-MEADOW.

WATER-Hen, in *Ornithology*. See FULICA CHLOROPUS, FLAVIPES, and RALLUS CAROLINUS.

WATER-Ouzel. See STURNUS CINALUS.

WATER-Rail. See RALLUS AQUATICUS, and BENGALENSIS.

WATER-Wagtail. See WAGTAIL.

WATER-Dog, in *Zoology*, a variety of the CANIS FAMILIARIS. See DOG.

WATER-Elephant. See HIPPOPOTAMUS.

WATER-Hog. See CAPIBARA.

WATER-Rat. See MUS.

WATER-Aidle, in *Agriculture*, a term applied to the stagnant water contained in moss land, in some places, as in some parts of the county of Lancaster. It is said to be highly prejudicial to animals, when they drink water that is mixed or impregnated with it. It is best removed from such land by proper draining, and frequent suitable tillage cultivation.

The bringing such wastes into a state of improvement consequently discharges it in an effectual manner. See MOSS and WASTE LAND.

WATER-Bailiff. See BAILIFF.

WATER-Barrow, *Swing*, in *Rural Economy*, an improved contrivance of this sort. See QUENDON WATER-BARROW.

WATER-Bearer, in *Astronomy*. See AQUARIUS.

WATER-Bellows, in *Mechanics*, a machine used to blow air into a furnace, by the action of a column of water falling through a vertical tube. The orifice where the water enters the tube is so contrived, that the water shall be mixed with air when it enters the pipe; and this air will be carried along with the stream through the tube, and is collected into a proper receiver, from which it is conveyed to the furnace in a continued blast. These machines are much used on the continent, but have never been introduced in England, because they will not produce by any means so great a current of air as may be raised by the same fall of water, when employed to work bellows, or other machines, by means of a water-wheel.

M. Reaumur has given a minute description of the water-bellows employed for the iron furnaces, in the provinces of Dauphiné and Pays de Foix, in France, where such machines are called *trompes*. The water is conducted to the furnace by a trough or passage, having an inclination of one inch in a toise; the body of the trompe is a vertical tube, about 27 French feet in height, and 16 inches diameter on the outside: it is made of two pieces of fir hollowed out, and bound together by hoops of iron.

The form of the interior of the tube contributes materially to its effect. The mouth or upper orifice, where the conduit-trough pours the water into it, is 13 inches diameter; from this it diminishes, in the manner of a conical funnel, till at a depth of three feet from the mouth, it is only four inches diameter, which part is called the throat. Here the opening of the tube enlarges all at once to a size of nine inches, which it continues for all the rest of the height. Immediately beneath the throat, (that is, the upper part of the

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the tube where it becomes nine inches diameter,) ten vent holes are bored through the sides of the tube; they are cylindrical, and two inches diameter; their direction is inclined, so that they point downwards at about an angle of 45 degrees; they are arranged at equal distances round the tube in two rows, the upper row having six holes, and the lower row four: it is through these holes that the air enters. The tube is supported in a vertical position by a framing, and the lower end is introduced into a strong ton or cask, six feet deep, and almost as much in diameter, though it is rather smaller at top than at bottom. The tube descends through the head of the cask 18 inches, so that it terminates within $4\frac{1}{2}$ feet of the bottom of the cask; and a kind of table made of a flat round stone, or a plate of cast-iron, is placed horizontally in the centre of the cask, at 18 inches beneath the orifice of the tube, being supported by a cross of wood, placed upon four legs, from the bottom of the cask. The cask is well closed on all sides, particularly round the tube, where it passes through the head; but there is an air-pipe conducted away from the top of the cask, to convey the air to the furnace; and from the bottom of the cask there is an opening, by which the water can pass away. The opening is regulated by a wooden shuttle, which pens up the water to such a height within the cask, that the opening through which the water issues will be always beneath the surface of the water, so as to prevent the escape of the air by the same passage.

The action of this machine is not so easy to explain as its structure, and it has at various times occupied much of the attention of philosophers. Father Kircher was the first who described the machine in his *Mundus Subterraneus*; but he did not satisfactorily explain the reason of its action. In the *Memoires des Scavant étrangers*, Barthes, the father, has given a theory which is very defective; and Dietrich was of opinion that the air was produced by the decomposition of the water.

M. Reaumur explains it thus:—The funnel of the tube is always full of water, which issues rapidly through the throat; but finding immediately a larger place, the stream disperses and scatters into drops, because it is no longer enclosed within a cylindrical surface: it does not, therefore, take any constant figure, but the stream is composed of different small streams, or rather successions of drops, which are continually changing their position with respect to each other. Now the intervals between these separate streams or drops are occupied by the air which is within the cavity of the tube: suppose that between two streams separated by air a third comes to descend, it will push the air before it with all its force, and carry the air down to the cask; and this will be replaced by fresh air, entering at the vent-holes. The irregular arrangement which the streams or drops take, either at their issuing from the throat or in continuing their fall, is such that few drops do not carry some air down before them into the cask: the water falling upon the table within the cask dashes on all sides, and releases the air which rises in the cask, and issues through the air-pipe to the furnace, whilst the water falls to the bottom of the cask, and escapes gently through the sluice.

A single trunk of the dimensions just described is found sufficient to blow a forge or finery; but for a smelting furnace, three are joined together, having a common trough of supply, and the air-pipes from the three casks are joined together. M. Reaumur supposed that a greater height of the fall would produce more air, because it is longer exposed to those changes of position in the different streams of water; but he supposed that no adequate advantage would be gained by an increase of the diameter of the tube, because

it would be more likely, in falling in a large body, to descend in a closer column.

The machines of the Pays de Foix are somewhat differently constructed: in these the water is conveyed into a reservoir, from the bottom of which a square trunk or tube descends to the reservoir or air-chest, which is made very long; and the air-pipe proceeds from an elevated part of it, to prevent the danger of spray or small drops being carried into the furnace. Instead of a throat and the vent-holes, the tube is made to divide into two branches, at the point where it passes through the bottom of the upper reservoir: these branches rise above the surface of the water in the reservoir, so that it cannot enter into them, but the water is admitted at an opening between these two branches, so that in effect the tube is divided into three, the centre being an opening for the water to descend, whilst the two outside branches admit the air to mix with the water and go down.

The editor of the *Art des Forges* supposes that the vent-holes are useless, but that the violent agitation of the water in passing the throat, and dashing upon the table within the cask, is sufficient to change the water into air. This is the same hypothesis as that of Dietrich.

These various explanations rendered the subject still more obscure; and in 1791, the Academy of Toulouse invited philosophers to determine the cause and the nature of the stream of air which is produced in these machines. M. Venturi, professor of philosophy at Modena, gave the real answer in an excellent paper on the principle of lateral communication of motion in fluids.

To explain the principle, this philosopher supposes a number of equal balls to roll along in a horizontal trough, in contact with each other, with an uniform motion at the rate of four balls in a second: suppose, on arriving at the end of the trough, they fall suddenly to a depth of 16 feet. Now, from the laws of gravity, each ball will perform this descent in a second of time; and as four balls succeed each other in each second, it follows that there will always be four balls in the air at the same time. The relative positions of these will be as follows: the uppermost ball will be one foot from the point where they begin to fall, the second four feet, the third nine feet, and the fourth sixteen feet. This arises from the acceleration which always takes place in descending bodies. A consideration of this circumstance will give a proper idea of the disunion and successive separation of the particles which the accelerating force of gravity produces in fluids, or in bodies which fall in a stream.

The rain-water flows out of gutters by a continual current; but during its fall, it separates into portions in the vertical direction, and strikes the pavement with distinct blows. The water likewise divides, and is scattered in the horizontal direction. The stream which issues out of the gutter may be one inch in diameter, and strike the pavement over the space of one foot. The air which exists between the vertical and horizontal separations of the water which falls is impelled, and carried downwards. Other air succeeds laterally; and in this manner a current of air or wind is produced round the place struck by the water. M. Venturi went to the foot of the cascades which fall from the *Glacière of La Roche Mélon* on the naked rock at *La Novalèse*, towards mount *Genis*, and found the force of the wind to be such as could scarcely be withstood. If the cascade falls into a basin of water, the air is carried to the bottom, whence it rises with violence, and disperses the water all round in the form of a mist.

He formed one of these artificial blowing engines of a small size; the vertical pipe was two inches in diameter, and

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four feet in height: it was a plain cylindrical tube, without any throat or funnel. But he found, when the water accurately filled the section of the orifice, and all the lateral openings of the pipe were closed, the pipe no longer emitted any wind.

According to this writer, the circumstances which favour the most abundant production of wind are as follows:—The separation of the descending balls is more rapid in the upper than in the lower part of the fall. In order, therefore, to obtain the greatest effect from the acceleration of gravity, it is necessary that the water should begin to fall at the orifice of the vertical tube with the least possible velocity, and that the depth of the water in the horizontal trough should be no more than is necessary to fill the section of the vertical tube. The vertical velocity of this section is supposed to be produced by a height or head of water in the trough, of a depth equal to the diameter of the tube.

We do not know by direct experiment the distance to which the lateral communication of motion between water and air can extend itself, but we may with confidence assume that it can take place in a vertical tube, whose section is double that of the original section with which the water flows from the trough into the pipe. Let us then suppose the section of the pipe to be double the section of the water in the trough, and in order that the stream of water may extend and divide itself through the whole double section of the pipe, some bars, or a grate, are placed in the orifice of the vertical tube, to distribute and scatter the water through the whole internal part thereof.

Since the air is required to move in the blowing-pipe with a certain velocity, it must be compressed in the receiver. This compression will be proportioned to the sum of the accelerations which shall have been destroyed in the inferior and close part of the vertical pipe, that is, the part beneath the vent-holes. Taking this closed part of the pipe $1\frac{1}{2}$ foot, we shall have a pressure sufficient to give the requisite velocity in the air-pipe. The sides of this portion of the pipe, as well as those of the receiver, must be exactly closed in every part, to prevent the escape of the air.

The lateral openings in the upper part of the pipe may be so disposed and multiplied, particularly towards the top, that the air may have free access within the tube.

In some machines of this kind, the constructors seem to have been of opinion, that a great height was required in the water-fall; but Dr. Lewis, who made a great number of experiments upon the subject, shews that an increase in height can never make up for a deficiency in the quantity of water; four or five feet, he thinks, is a sufficient height for the water to fall: and where there is a greater height, it may be rendered useful by joining two or more machines together in such manner, that when the water has once committed its air in the condensing cask or vessel, it shall flow out into a new reservoir, and from thence descend through another funnel and cylinder, and fall from it into a condensing vessel, where the air is extricated and carried off through the air-pipe.

Another kind of water-bellows was invented by the ingenious Martin Triewald, of Sweden, and is described in the Philosophical Transactions. The machine consists of two casks or tuns open at bottom, and so loaded, that they will sink into water in the same manner as diving-bells. These being so suspended that they can be alternately lowered down into water and drawn up again, will by proper valves and pipes afford a continual blast of air.

Fig. 15. *Plate Water-works*, represents these water-bellows in profile. A A are two casks, made nearly the same shape as diving-bells, being in the form of a truncated cone, or

wider below than at top, where they are furnished with close heads B B, but at the lower ends A A are quite open. In the heads B B are valves V, which open inwardly, and are made like the palates of other bellows, with their hinges and the valves themselves covered with hatters'-felt. They are cauled to shut by easy steel springs till the air from above opens them, which happens only when the bellows receive their motion upwards. The valves are shut by means of the pressure of the air within, when they sink down into the water.

On the same heads two pliable leather tubes R R are fixed, one at the top at each water-bellows, which tubes are made and prepared in the same manner as those used in water-engines for extinguishing of fire. These leathern tubes or pipes reach from the bellows to the tubes T T, which carry the wind into the furnace, or any other place, according to pleasure.

These two bellows are suspended from the lever by iron chains K K, which are fastened to two sweeps S S, by which means they hang perpendicular from the balance-beam, and at the same distance from the centre of its motion C on the opposite sides. On the top of this balance-beam are fixed two sloping gutters F F, into which the stream of water runs from the gutter G, and gives motion to the whole work, performing the same service as an overshot or any other water-wheel; but they cost much less, and give as even and regular motion as a pendulum, for as soon as so much water runs into either of the inclined planes of the gutters F F, that the weight of the water exceeds the friction near the centre of motion C, and the weight of that bellows which is sunk down into the water, the gutter immediately descends with an increasing velocity till the balance meets with the resistance of the wooden springs H H; during this time it has raised the opposite water-bellows, or that bellows which is fixed under the opposite gutter, the gutter which has been filled being come down to the spring H, delivers all the water it has received, and at the same time the water begins to run into the opposite gutter, which receives its load of water almost as soon as the former is emptied, so that one of the gutters begins its effect as soon as the other has finished, and this continues alternately as long as the stream of water is supplied. These sloping gutters upon the balance-lever, therefore, perform all the effect which a water-wheel does in working the ordinary bellows, and by means of the same power of descending water, but acting reciprocally on opposite ends of the balance-beam.

These water-bellows blow the fire on the same principle, which produce the effect of the ordinary bellows, viz. that the air which enters the bellows, and which they contain when the top is raised, is again compressed or forced into a narrower space when the bellows close; and since air like all other fluids moves to that place where it meets with the least resistance, it must consequently go through the opening which is left for it, with a velocity proportioned to the force by which the air is compressed, and must blow stronger or weaker in proportion to the velocity with which the top and bottom of the bellows are made to approach each other; the blast also will last a time proportioned to the quantity of air that was drawn into the bellows through the valve or pallet.

The same operation takes place in the water-bellows, for the air which they contain must necessarily be compressed by the water, which rises alternately into the bellows A A, and obliges the air to go through the leathern tubes R R, as being the place where the air meets with the least resistance.

In this machine, the chief part of the weight to be moved

moved is balanced in equilibrio, for the bellows A A may be considered as two nearly equal heavy weights in a pair of scales, which in a great part balance each other. The difference is occasioned by that bellows which sinks down into the water, being so much lighter, as it loses its weight by the quantity of water it displaces, from the bulk of air contained beneath the surface of the water. This difference is compensated by the weight of the water which falls down along the sloping gutter, which acquiring the power of a falling body, increases in the same proportion as the bellows to be raised by it increases in weight; for the bellows which sinks down into the water does not at once lose its weight in the water, but gradually as it descends deeper; and in the same manner, the ascending bellows does not at once become heavier than the other, but the weight gradually increases from the time it is first raised till it is quite raised.

Mr. Hornblower some years ago proposed an hydraulic bellows of the same kind as M. Triewald's, except that, to avoid the flexible tubes of leather R R, he employed a lead pipe to go down to the bottom of the cistern of water in which the bellows descended, and turn up again beneath the bellows, so that the orifice of the pipe was above the surface of the water; it therefore communicated at all times from the interior of the bellows to the furnace. Mr. H., in Nicholson's Journal, mentions a very striking difference between these water-bellows, in which the moving chest was eighteen inches square and moved perpendicularly nine inches, and a common pair of smith's leather-bellows of thirty inches long.

The leather-bellows threw considerably more air to the fire, and its nozzle, compared with the water-bellows, was as 73 to 60 in diameter, but it did not produce so great an effect in bringing on the heat; and the noise of the water-bellows was so great as to almost drown that of the common one. The only difference in other respects is, that in the hydraulic bellows, the pipe went under ground for about eight feet, and the connecting pipe of the other came down about the same distance from the shop above.

WATER-Bomb, a name given by our chemist Godfrey to a machine he invented on the plan of Greyl's discovery, for the extinguishing of accidental fires in houses. He considered first, that the unchangeable size of Greyl's engine was a very great objection, and on this plan contrived a medicated liquor, which was such an enemy to fire, that a very small quantity would extinguish as much as a much larger of common water; and this liquor had the farther advantage, that it might be kept ever so long without corrupting, and by that means the vessels containing it would remain always fit for use; whereas in Greyl's method they must have been rotted by the corrupting and fermenting of the water, after a few years. The author of this invention tried it twice in public with us, and both times with all the success that could be wished; but the structure of the vessel was so much the same with that of Greyl's, that Godfrey cannot be allowed any farther merit as an inventor, than that of contriving the medicated liquor instead of common water. The machine is a wooden vessel, made very firm and strong, that the liquor, when once put in, cannot leak out any where; in the centre of this is an oblong cylindrical vessel, which is filled with gunpowder; a tube is brought from this to the head of the barrel; and this being filled with combustible matter, and the inner case with powder, and both made of plate-iron, that no water may get in, the vessel is then filled with the medicated, or antiphlogistic liquor. The top of the tube is then covered, and the thing set by for use.

When there is occasion for it, it is only necessary to uncover the tube, and setting fire to the matter in it, it is conveyed to the vessel containing the powder, and the whole machine being thrown into the place where the fire is, is torn to pieces by the explosion, and the extinguishing liquor scattered every way about, on which the fire is quenched in an instant.

The contriver of these things proposed the making of three kinds of them, the one containing five gallons of the liquor: this was the largest size, and contrived for the largest rooms, and most urgent necessities. The second kind contained three gallons; and the smallest, which was meant for a closet, or other little room, contained only two gallons. Those of the smaller kind also had sometimes a peculiar difference in their structure, the powder-vessel being placed not in the centre, but at the bottom: the intent of this was to fit them for chimneys, when on fire, as by this means the liquor, not being wanted to be scattered on all sides, was carried mostly upwards. These were fixed on the end of a long pole, and by this means thrust to a proper height up the chimney; and the tube that communicated the fire was placed downwards.

The manner of using the machines for rooms on fire, is this: the person who has the care of them is to throw them as nearly as may be into the middle of the room, and then to retire to a little distance: as soon as he hears the explosion, he may safely enter the room, and with a cloth, or any thing of that kind, put out any remaining sparks of fire that there may be in particular places. If the room be so large, that one of the machines cannot disperse the liquor to every part of it, two are to be used, one being laid at each end: and if several rooms are on fire at once, as many of the machines are to be used, one being thrown into each room. If a whole house is on fire, the lower rooms are first to be taken care of, and after these the upper, as they ascend.

Our Godfrey had scarce better success than his predecessor Greyl; for while he was making his public experiments, one Povey, collecting some of the fragments of his broken vessels, found out the ingredient used in the medicated liquor, and made and sold the things in the same place where he had proved his right to them. It is probable that the medicated liquor was no other than common water, with a large quantity of sal ammoniac, that salt having this virtue of extinguishing fire in a very remarkable degree. But it is to be greatly wondered at, that while all the world were convinced by experiments of the use of the machine, the author made but little advantage of it, and it is now disused. *Act. Erudit. Ann. 1724, p. 183.*

The society of arts and manufactures, &c. made trials of balls prepared in Mr. Godfrey's method, by his grandson, in a proper edifice erected for this purpose; and they found, that, after the fire had prevailed for a considerable time, and the flame forced its way through the chimney and windows, it disappeared, and was entirely extinguished by the explosion of two of these balls. See *FIRE, Extinguishing of.*

WATER-Borne, in the *Sea-Language*, denotes the state of a ship, with regard to the water surrounding her bottom, when there is barely a sufficient depth of it to float her off from the ground; particularly when she had for some time rested thereon.

WATER-Camblots. See *CAMBLET.*

WATER, Cataract of. See *CATARACT.*

WATER-Clock. See *CLEPSYDRA.*

WATER-Colours, in *Painting*, are such colours as are only diluted

diluted and mixed up with gum-water: thus called, in contradistinction to *oil-colours*. See WASHING.

The use of water-colours, makes what we call LIMNING; as that of oil-colours does PAINTING, properly so called.

Painters in water-colours have been often afflicted with the disease called colica pictonum, occasioned by the poisonous quality of several of the pigments which they use; and which, by putting the point of their pencils between their lips, whilst they are studying their subject, they insensibly swallow. Dr. Fothergill says, that, when the vomitings are abated, copious discharges by stool are procured, and the functions of the bowels in a degree restored to their usual state by the method pursued in the cure of the colica pictonum; nothing contributes so effectually to restore the use of the limbs, when impaired by these causes, as the liberal and constant use of the tinctura guaiacina volatilis; which may be given in such quantity, as to keep the body gently open; mixed with a little common sugar or honey, and then diluted with any weaker mucilaginous liquor, as thin gruel, or barley-water, or marshmallows-tea. Med. Obs. vol. v. p. 394.

WATER-Cisterns, for *Rural Purposes*, such as are formed for different domestic uses. In high, dry, upland situations, cisterns of this kind are of great utility and importance in many parts of the country. In the account of the agriculture of the North Riding of Yorkshire, it is stated that in the high eastern parts of it, water-cisterns or reservoirs are made by the inhabitants within the ground, which are highly useful: these, it is said, are fed by the rain-water which falls upon the roofs of the buildings, and is conducted from thence by spouts. That in these cisterns a very ample supply of soft water is always ready at hand; and that by their being under ground, and kept close, the water is sweet and suitable for every domestic or other use.

A water-cistern of this sort is stated to be formed in this manner. A cube of the required size being dug in the ground, and the sides made even and perpendicular, the bottom is covered with so much clay, as that, when well beaten, will be four inches thick; a foundation of stone is then laid round the sides; upon the clay, a brick floor is laid in terras, the surface of which should not be lower than the top of the foundation; the sides are then built a single brick thick, and the bricks laid in terras, a foot space being left betwixt the wall and the earth, which is gradually filled with clay in a soft state; and this well beaten as it stiffens; the whole is arched over, leaving a hatchway for a man to go in and clear it out, and an opening or passage into a drain, for the surplus water to run or be taken off, when the cistern is full.

The water is raised for use by means of a pump. In these cases, as keeping all external air out of the cistern contributes, it is said, much to the sweetness of the water; the pipe by which the cistern is fed should be continued to within a few inches of the bottom, and the surplus water be conveyed off by a pipe rising from near the bottom to the extreme height the water is designed always to be at, when that takes place, and there communicate with the drain: by these precautions, it is said, there will be no more of the surface of the water exposed to the external air, than what is within those pipes and that of the pump.

This method of forming water-cisterns may be found useful, cheap, and convenient, in many places, where such water is necessary to be preserved pure and sweet.

Cisterns of this sort have sometimes the title of water-cellars, and are of great convenience and use for farm-yards. See WATER, River, Collecting of, and WATERING Live-Stock.

WATER-Courses, in *Agriculture*, are such large ditches or passages for taking off the water as are formed, and remain constantly for the purpose in different places, and properly belong to the public.

They should be kept constantly well opened and cleared out, not having too much fall given them, so as to destroy the evenness of their bottoms. See SEWER.

WATER, Cut. See CUT-WATER.

WATER, Dead, in *Sea-Language*. See DEAD-WATER and SHIP-BUILDING.

WATER-Engine, in *Mechanics*, denotes either an engine to raise water, or any engine that moves by the force of water.

WATER-Falls, in *Ornamental Gardening*, are those falls of water which are formed and introduced in pleasure or other grounds for the purpose of producing ornamental and picturesque effects, or which naturally exist in such situations. They are of different kinds and forms, being sometimes of the nature of cascades, and at other times contrived for the intention of driving some particular sort of interesting machinery, so as to afford an agreeable and striking picture in the rural scenery of the particular place where they are had recourse to. They are usually constructed, where they do not exist naturally, either by means of large rocky stones thrown rudely together into a sort of ridge form of head, over which the water passes, formed in the way of weirs, or built in masonry in a careful and exact manner, according as the different nature of the circumstances and situations may require. See WATER.

Mr. London, in his useful work on "Country Residences," has well described and delineated several different modes of forming water-falls. They should, he thinks, be natural, strong, and lasting, from the general form of the whole of the materials, the security and solidity of their foundations, and the quality of the work and materials used in building them.

WATER, Foul, in *Sea-Language*. See FOUL.

WATER-Fowl. See FOWL.

WATER-Furrow, in *Agriculture*, a deep open furrow drawn by the common or a large double mould-boarded plough made for the purpose, in a proper direction of the field in arable lands, or those in the state of tillage, for the use of conveying and taking off the superabundant hurtful water, and preventing the stagnation of it from injuring the crops. This is especially necessary and proper in the winter season, and often in others. It is therefore essential that, as soon as possible after sowing most sorts of grain, but particularly wheat, when there is any disposition in the soil or land to the retention of moisture in too large a proportion, there should be as many water-furrows opened in this way as may be sufficient for carrying off and completely removing the excess of water, and thereby preserving the ground in a properly dry and sound condition for the healthy growth of the crops. It is observed by the writer of a late Calendar of Husbandry, that the making of proper water-furrows is a circumstance of much importance in the culture of wheat, but that it is oftentimes strangely neglected. It is a work, however, that should be well and effectually performed on all lands, except those that are perfectly dry all the winter through. The water-furrows should be formed by the plough, as soon as the field has been finished ploughing, sowing, and harrowing, and then a spit of earth should be dug from out of the bottoms of them, and laid on one side opposite the rise of the land or ridge, and the loose mould in the bottom parts be well snowelled and cleaned out, so as to make a perfectly free passage for drawing off the wetness; the openings of all the common ridge-furrows being

being likewise well cleaned at the same time, so that the water may have an easy fall out of every one of them into the large water-furrows. The number of these large furrows must constantly depend on the variations of the surface, and some other circumstances of the lands: the only general rule is to make them so many in number, as that no water may be suffered to stand on any part of the land in the wettest weather. In the bottoms or low parts of fields, or in other places of them where there is a double slope of the land, it is necessary to form and cut double water-furrows at the distance of about a yard or four feet from each other, in order to take the water from each descent singly.

The same writer, too, farther advises, that in all lands sown with clover or other grasses among the corn, these sorts of furrows should be dug a spit deep, and the mould raised in that way be carefully thrown out. Many farmers, it is said, are not attentive enough to this point. They only scour the furrows in such cases. They should, however, it is thought, consider how long the grass crops are on the ground, which may be two or three winters; consequently it must be very material to such crops to lie dry all that length of time, which scouring alone will not effect, at least not in a sufficiently perfect manner. Particular attention should also be paid to the spreading of the earth that is dug out of the furrows in these cases, as if the men be not cautioned, they will lay it too thick and injure the crops; it should be chopped and rendered small, and then spread with great care, in order that the seeds may rise freely through it.

In the case of arable land, these furrows should be often examined during the winter season, to see that they are perfectly open and free; the clods, lumps, and other such matters that may have fallen into them, being cleared out by means of the spade.

This is a practice which is either much overlooked, or very imperfectly executed, in a great many districts of the kingdom. The sides of the furrows in these cases should always be made to stand firm, and to have a good slope each way, which prevents their falling in and mouldering down so much. The name of water-furrow drain is sometimes given to this sort of furrow. See *WATER-Furrowing*.

WATER-Furrow Fall Plough. See the next article.

WATER-Furrowing, a term used to signify the operation of opening water-furrows. It is a sort of work mostly executed by the assistance of a large plough for the purpose and the spade, but sometimes by the plough alone. And in some parts of the county of Essex, particularly in the neighbourhood of Colchester, they have a method of doing it by means of a machine that is termed a fall-plough: in the lines where this sort of furrowing is to be performed across the fitches or ridges, this sort of tool is used there once in six, seven, or eight years, for the purpose of lowering, or, as they call it, *falling* the surface. They first gather four or six furrows by the plough; then follows this implement across these furrows, in their loose fresh ploughed state, taking up the parts of the mould, and dropping them on the crowns or sides of the fitches or ridges, and when finished, the water-furrows are ploughed and scoured in the common manner: the invention is said to have merit, as the water certainly takes a freer course than in the usual method. In a dry season, a large extent of ground can be done in a short time, at little expence, in this way.

Some think this work done in the neatest and most effectual manner by means of a shovel; and that an old worn shovel is the best for the purpose. See *WATER-Furrow*.

WATER-Gage, the name of a simple contrivance for measuring and ascertaining the depth or quantity of any water

in its application to any purpose, or otherwise. See *GAGE*.

WATER-Gang, a term applied to a channel or passage cut through any spot to drain and free a place of water by carrying off a stream from it.

WATER-Gavel, in our *Old Writers*, a rent paid for fishing in, or other benefits received from, some river.

WATER-Gilding. See *GILDING*.

WATER-Lanman, a small glass instrument, which is a tube of about three-quarters of an inch in diameter, with a ball about $1\frac{1}{2}$ inch at one end, the other end being hermetically closed; the ball contains water, and the empty space is rendered nearly a vacuum by boiling the fluid previously to sealing it. In this instrument the heat of the hand applied to the wetted tube, is sufficient to produce bubbles of vapour, which enter the ball, but speedily collapse. The series of these condensations is as quick as 15 or 16 in a second. But in the steam-engine the condensation is prodigiously more rapid. When a small double steam-engine, on the construction of Boulton and Watt, having all the parts and gear of the large engines, but its cylinder being only $2\frac{1}{2}$ inches diameter, and the length of stroke $6\frac{3}{4}$ inches, was set to work; it gave 600 strokes *per* minute, or about twice as many as the beats of a common watch. By an easy calculation it may be shewn, that the steam condensed was then much more than 300 cubic inches *per* second; and if the condensation, instead of being effected in masses of about a pint at a time, could have been performed by successive collapses of each cubic inch in an open space, the pulses would have produced the tone of the lowest E flat in the treble cliff. But the number of cubic inches condensed in a large steam-engine, *e. g.* a three-foot cylinder with an eight-foot stroke, will be eight or nine times as much at the usual rate of working. See *Nicholson's Journal*, vol. iv. 8vo.

WATER-Level, the level which is formed by the surface of still water, managed in some way or other in a convenient manner for its application in different cases; and which is perhaps the truest of any for most uses. The term is also applied to and signifies the level used in watering land, and performing different other operations in the business of agriculture. See *LEVEL*, *SPIRIT-LEVEL*, and *WATERING Land*.

WATER-Levels are also lengths of canal in some places, that are not connected by locks with other navigations; but at the ends of which the goods are unloaded into team-waggons. See *CANAL*.

WATER-Line and Reel, the strong large line and reel of the garden kind, which is used in forming some part of the works in watering of land.

WATER-Lines, (see *SHIP-Building*), are the lines of floatation supposed to be described by the surface of the water on the bottom of a ship. Of these the most particular are those denominated the *light water-line* and the *load water-line*; the former, namely, the light water-line, being that line which shews the depression of the ship's body in the water when light or unladen, or when first launched, called the *launching draught of water*; and the latter, which exhibits the same when laden with all her guns and ballast, or cargo.

WATER-Logged, in *Sea Language*, denotes the state of a ship when, by receiving a great quantity of water into her hold, by leaking, &c. she has become heavy and inactive upon the sea, so as to yield without resistance to the effort of every wave rushing over her deck. In this dangerous situation of a ship, the crew have no resource, except to free

her by the pumps, or to abandon her by the boats as soon as possible.

WATER, To Make. See *MAKE*.

WATER-Machine. See *MACHINE*.

WATER-Mead or *Meadow*, in *Agriculture*, a term applied to that sort of meadow or other inclosed low ground, which is capable of being improved and kept in a constant state of fertility and productiveness, by means of water from some adjoining river, brook, or stream, being thrown and conducted over it in the winter or other proper season. This manner and beneficial practice of forming meadows has prevailed locally for such a very great length of time in different parts of the country, especially in Wiltshire, Gloucestershire, and Devonshire, that it is extraordinary that it has not been generally adopted and introduced into other districts, where it is equally capable of being had recourse to without great difficulty, and where it may be equally advantageous and proper. This neglect has been ascribed by a late intelligent writer to a deficiency of information among farmers in general, in regard to the nature and management of the business, and particularly in what relates to the nature of levels, and the means of adjusting them in different cases. These circumstances, it is supposed, have confined it to the western districts and parts of the kingdom. Other causes may, however, have operated in this way, as the facilities afforded by the situations of the lands in general, the numerous rivulets and streams always ready at hand for the purpose, and many others of the same nature.

It is necessary that water-meadows should have such a form, either by nature or art, as that this fluid may be capable of flowing over their surfaces in a rapid manner, in order to produce and promote the early and quick growth of the grass in a healthy state. It is essentially necessary, too, to their perfect success and completeness, that there be at all seasons a full command of the water, as well as of the means of distributing it to every part of them, and of discharging it in a complete manner, whenever it may become requisite. See *WATERING Land*.

As to the advantages to be derived from meadows of this kind, they are very considerable, not only in the vastly increased quantities of hay which they afford, but also in the point of early spring food for ewes and lambs, as well as in many other respects and particulars.

It may be observed, that from the grass of water-meadows being so very forward in the months of March and April, it is in general fed down or pastured in the spring with sheep; and to those farmers who keep them for breeding or fattening, becomes almost invaluable, from the great scarcity of green food at such a period; but that after being flooded in the latter end of the last of these months, they are mostly shut up for hay in the summer.

And the after-grass is eaten off in autumn by neat cattle, it being considered as very pernicious and dangerous for sheep to pasture on water-meadows at that season. A remarkable instance of its fatal effects is stated by the writer of the *Corrected Account of the Agriculture of the County of Suffex*. Eighty ewes from Weyhill fair were turned into some field adjoining a watered meadow: a score of them broke into the meadow for a night, and were taken out in the morning, and kept till lambing; when they produced twenty-two lambs, all of which lived, but every one of the ewes died rotten before May-day. The remaining sixty made themselves fat, nor could a rotten sheep be discovered amongst them. It is an extraordinary fact, it is said, though not easily accounted for, that the grass of watered meadows should be so nourishing to sheep in the spring, and yet have so destructive an effect on them in the

autumn. The fact seems, however, to be well and indubitably established. It may probably depend upon the grass being in a more soft and loose watery state of production in the autumn than what it is in the vigorous growth of the spring. See *TATH* and *WATER-Tab*.

By the author of the "*Treatise on Watering Meadows*," it is advised that no sheep, except those that are just fat, should ever be suffered, even for an *hour*, in watered meadows, as they will infallibly rot them at any other season than the spring, but especially if made from low, boggy, or swampy ground; but that it is not so, when made from dry heathy land. Others, however, think it dangerous on all, and therefore always to be avoided.

It cannot be doubted but that on farms of this nature, where it is convenient to have three or four meadows that can be watered, they will be found particularly advantageous; as, while neat stock are eating the first, it is said, the second will be growing, the third becoming dry, and the fourth under water: by which an extensive system of feeding and producing of dry fodder may be carried on.

It is noticed by Mr. Smith, in a late essay on these kinds of meadows, that even a small piece of this sort of meadow, which will produce an early crop of spring feed at the very time of the greatest pressure of scarcity, and when the turnips ought to be off the ground, must be much more valuable to a poor arable farm than can easily be imagined by any one who has not witnessed the great utility derived from them, in many parts of Wiltshire. What, but for the water-meadows, could enable the Wiltshire farmers, it is asked, to bring to market a much greater number of sheep, and that at an earlier season than can be produced from any other county in the kingdom? The water-meadows have unquestionably a great share in doing this.

They afford there, it is said, an early supply of grass for the forward or early breed of lambs, on which they begin to feed them about the middle of March, having previously withdrawn the water from them, and laid them perfectly dry. It is observed, that on a good crop of grass of this kind, it has been said, that five hundred couples may be fed on an acre for one day. The practice is to hurdle out, daily, such a portion of the ground as is necessary, leaving a few open spaces in the hurdles, through which the lambs may feed forward on the fresh grass. The hours they are suffered to feed on this grass, in such cases, are from about ten o'clock in the morning until five in the afternoon, when they are generally folded on the contiguous barley fallows, or lands in preparation for that crop. This is a practice or sort of management, too, which is supposed to have a great advantage, in consequence of its manuring a part of the farm without the dunghill. The manure, however, in such cases, is drawn from, and at the loss of such meadows.

The writer of the *Corrected Report of the Agriculture of the County of Middlesex* mentions a remarkable instance of the beneficial and fertilizing effects of water in these meadows, as occurring in the early part of the autumn of 1796, when such grass lands as had not had the advantages of water, as in these cases, were nearly burnt up. A close of about twenty acres, which had been watered in this way, had, it is said, a most luxuriant after-grass of from six inches to a foot in depth; and a neighbouring inclosure of near forty acres afforded support for three months to forty-seven horses and bullocks, all which thrived very well. And another case of the same nature is recorded, in which forty acres employed in this way were found equal to the support of five hundred Wiltshire ewes, from the middle of the month of March to the first of May, or about six weeks; and

and that the improvement of the stock in that time was one shilling a week, or three pounds fifteen shillings the acre. In some parts of the same county, five pounds worth of hay might also, it is said, be taken off the first week in May. These facts and statements strongly prove and display the utility of these meadows, wherever they can be properly provided.

In speaking of the management of water-meadows, the author of the essay already noticed remarks, that in those great districts of water-meads, which in Wiltshire are watered by the common consent of many different proprietors and occupiers of land, the operation of floating must begin and end at certain fixed periods, which it is necessary for every one to know, and regularly adhere to, not only in order to the production of a crop of grafs, but for the procreation of those animals that eat the grafs: consequently, as every farmer knows at what time he shall have grafs for his sheep, he so manages his breeding flock, that his lambs may be strong enough at the usual time of feeding to go with the ewes to take their food in the meadows, and return to the fold for lodging.

It is noticed, that the time to commence the feeding on the meadows upon those large streams in this county is generally about the twenty-fifth of March: therefore, if the winter be very mild and favourable for the growth of grafs, it sometimes gets to such a height as many farmers, unaccustomed to the herbage, might think to be much too coarse and luxuriant for sheep, and even too high to be fed off with cattle. So great was the luxuriance of the grafs in the water-meads of Wiltshire, it is said, some years since, occasioned by the mild growing weather immediately after the commencement of floating, that some farmers laid their meadows dry, and fed them off in November, and the following month; and then, by floating again, obtained a crop of feed in the spring before the usual period. Many who did not adopt this method lamented that their grafs was too high, even in the month of February; and it was then not uncommon to see it in the water-meads nine inches high, but laid on the ground, and white at the bottom, before the lambs were strong enough to go into the meadows. Some apprehended, it is said, that the long four grafs would be wasted; yet it was astonishing with what avidity the sheep devoured it, and even preferred the parts that were the longest, and rendered white at bottom, in consequence of the extreme thickness: this they would, it is observed, gnaw down to the very roots. It was remarked by Mr. Davis, it is said, that the grafs then on one Rickwood's mead was such a crop as, at the usual time of cutting it, would have been estimated at 18 cwt. *per* acre. Many declared that they never saw the crop of the water-meads so very abundant and early; but on visiting the same meadow, at the particular request of the above-named friend of the writer, on the tenth of March, when it had been in feeding more than three weeks, and asking the floater if they ever began to feed it sooner, he replied that he had had the management of the meadows more than thirty years, and never knew it so early but once, when they began feeding it on the eleventh of the first month in the year. The writer walked over the greatest part of this extraordinary piece of ground with some considerable difficulty, it is observed, from the thickness and height of the grafs; and he could discover but one place, to the great credit of the floater, which was worse than another, and that not two rods square. The man soon saw it noticed, it is said, and before the writer could mention the circumstance, told him he knew what he was looking at, and had contrived to do away even such a trifling defect: so this may be truly said to be, the

writer thinks, a spotless meadow. This shews the nice attention and great care bestowed in forming water-meadows in this district; and in some other counties the care bestowed upon the water-meadows is probably not much, if any less. This would seem to be particularly the case in the county of Gloucester, where very great attention is given to the floating of them, to the manner of feeding them down by live-stock, and the shutting them up for the production of hay, as well as in every other part of their management.

They are there, too, equally valuable and important in the quantity and utility of the produce which they afford, as well as the qualities of it, yielding much profit to individuals, and advantage to the whole district.

The utility and benefit of water-meadows are indeed now beginning to be every where well understood, wherever they are capable of being formed in a convenient and suitable manner.

Water-meadows are in general calculated to afford an early spring feed for sheep, or other sorts of live-stock, which may be continued in feeding by them until towards the beginning of the month of May, when, if designed for the producing of hay, that must then cease; as, if persisted in even for a single week in that month, the hay would, as supposed by some, be wholly ruined in quality, being rendered soft, woolly, and unsubstantial, as in the case of after-math crops: but being then shut up, and floated for some days, a crop of hay is next produced, which is in readiness for the scythe in about six weeks; and this crop being removed, and the meadows again floated as before, a third or after-math crop is afforded, for being pastured by neat cattle and horses, but never, or in few cases, by sheep, or for being used as cut green food in house-feeding, which, in some cases, is probably the most beneficial application of it; as where one or two more such crops are caused and taken in the same way, at the same season.

The great superiority of the produce from water-meadows is thus rendered very evident, and the uses of it not of less value or importance.

Water-meadows should constantly be well eaten down before they are floated, but especially in the autumn.

It is of great advantage, in many different respects, to have separate water-meadows, which can be alternately in the course of feeding off, floating, and being laid dry, as has been already seen; as, by this means, their benefits can never be lost for any length of time. And it is particularly beneficial in providing an uninterrupted succession of after-math pasturage, or of that sort of grafs for being cut and used green in the stalls.

Any thing which is done to the surfaces of water-meadows, in the way of rolling or giving them pressure, should always be done while they are in a quite dry state, about the beginning of the month of March, and never when they are much in a moist condition.

The hay produce of meadows of this sort is mostly proper for all kinds of neat cattle and sheep, but not so suitable for horses, especially those of the working or team kind.

WATER-Measure. Salt, sea-coal, &c. while aboard vessels in the pool, or river, are measured with the corn bushel heaped up; or else five striked pecks are allowed to the bushel. This is called water-measure; and this exceeds Winchester-measure by about three gallons in the bushel.

WATER-Microscope. See MICROSCOPE.

WATER-Mill, in *Rural Economy*, that sort of mill which is turned by the power or force of water applied in some way or other. As mills of this kind often form and oppose great obstructions to different improvements of the farmer,

and especially in the practice of watering land, they should consequently be diminished in number as much as possible in such cases, and those of the tide and wind kinds be substituted in their places, as might be done with great facility in many instances. See *MILL*.

WATER, Mother, in Chemistry. See *CRYSTAL*.

WATER Ordeal, or Trial, was of two kinds; by hot, and by cold water. See *ORDEAL*.

WATER-Organ. See *ORGAN*.

WATER, Petrifying. See *PETRIFYING*.

WATER-Poise. See *HYDROMETER*, and *ARÆOMETER*.

Dr. Hooke has contrived a water-poise, which may be of good service in examining the purity, &c. of water. It consists of a round glass ball, like a bolt-head, about three inches in diameter, with a narrow stem or neck, one twenty-fourth of an inch in diameter; which being poised with red lead, so as to make it but little heavier than pure sweet water, and thus fitted to one end of a fine balance, with a counterpoise at the other; upon the least addition of even $\frac{1}{1000}$ th part of salt to a quantity of water, half an inch of the neck will emerge above the water, more than it did before. *Phil. Trans. N^o 197.*

WATER-Proof Cloth and Leather. It would be very desirable to render the principal articles of clothing impenetrable to water, provided it could be done without injuring the pliability of the cloth.

The most common resource is to line the garment with oiled silk, such as is used for hat-covers and umbrellas; that is, silk which has been dressed with a varnish of drying linseed oil, so as to prevent the admission of water. This effectually guards the wearer of such a garment from becoming wet; but it is not perfect, for the outside cloth can imbibe moisture, which will evaporate by the wind, and cause great part of that coldness which renders wet clothes so prejudicial.

What would be desirable is, that we should give to cloth the same property which we find in the fur of several animals; the otter, beaver, and water-rat. This is a repellence of water, which when thrown upon the animal rolls off in pearl drops, without wetting the fur in the least; but we observe this only in the living animal, and when in a state of health, for these animals are known to be sick when they are found to be wetted after having dived in the water. This perfection has not yet been attained, but we shall proceed to state what has been attempted, with a view of water-proof varnishing for cloth.

Mr. Albert Angel, in 1781, had a patent for preparing an elastic varnish for this and various other purposes. His receipt is, linseed oil, or nut oil, one gallon; bee's-wax (yellow or bleached), one pound; glue or size, six pounds; verdigris, a quarter of a pound; litharge, a quarter of a pound; spring or rain water, two quarts; to be put into an iron kettle, and melted down till it forms the composition.

Caoutchouc, or elastic gum, called Indian rubber, is a substance which has engaged the attention of philosophers, ever since it has been known. Its singular elasticity, its flexibility and impenetrability to water, have caused it to be considered as very valuable for this purpose.

It is not possible to effect the liquefaction of caoutchouc, by means of heat; it will melt as well as other resins, but when cooled, it remains liquid and adhesive. Alcohol or spirit of wine, the usual solvents of resinous substances, do not act upon it, nor is it dissolved in water, as gums are; it was then tried to dissolve it in drying oils, and it was found that by the aid of heat, the caoutchouc may be dissolved, and form an excellent varnish, supple, impervious to air or water, and resisting a long time the action of acids.

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With such varnish Messrs. Charles and Roberts covered their air-balloons.

Several essential oils, as those of turpentine and lavender, act upon the caoutchouc, even when cold, and these are of no great price. The disagreeable smell of the oil of turpentine becomes, perhaps in process of time, less disagreeable than that of the lavender.

The oil of turpentine always leaves a kind of stickiness.

The following process is described in a patent granted to Mr. Henry Johnson of London in 1797, for rendering cloth and other articles water-proof.

The article to be operated upon, must first be cleaned from all grease or dirt by washing it with an alkaline solution, and then stretched in a frame. The water-proof compound, as it is termed, is formed by dissolving caoutchouc or Indian rubber in spirit of turpentine, (the smell of which is taken off by adding oil of wormwood, and spirit of wine in equal quantities;) this forms a sort of varnish, which is capable of being spread, or washed over the surface of the leather or cloth, always applying it on the wrong side of the article, or that side which is not to be seen. The varnish is laid on by means of a large piece of Indian rubber, instead of a brush or sponge. To conceal the varnish and make a good internal surface to the cloth or leather, it must be sifted over with some substance, such as silk, wool, or coney, cut very fine, in the same manner as flock paper is made; and being left to dry, in a few days the flock, by its adhesion to the varnish, forms a very good lining, at the same time that it conceals the varnish. These articles were called by the patentee hydrolaines, and were loudly recommended by advertisements, but never came much into use.

M. Pelletier's Method of making Varnish of Caoutchouc, or elastic Gum, by dissolving it in sulphuric Ether.—Boil the elastic gum for the space of an hour in common water, by this it becomes soft enough, to be cut into small threads; being thus divided, put it again into boiling water, and keep the vessel on the fire for about another hour; this second boiling penetrates the elastic gum very sensibly, and deprives it of that hardness which it possesses in the first state.

When the gum is thus divided and softened, put it immediately into a matras, or any other closed vessel, containing rectified sulphuric ether. In the course of a few hours the ether penetrates the elastic gum (which swells very considerably), and at the end of a few days the solution is complete, without the assistance of heat, provided a sufficient quantity of ether is made use of.

According to this process, the solutions are of a white colour and transparent; the heterogeneous and footy particles, which the elastic gum generally contains, fall to the bottom of the vessel in which the solution is made, and have a footy appearance, so that by merely decanting the solution it may be obtained very clear.

Mr. Parrish and Mr. Ackermann have likewise had patents for the same object; the latter succeeded much better than the elastic varnishes.

Water-proof Leather.—In the memoirs of the Academy of Sciences at Turin, 1789, is a paper by the chevalier de St. Real, on the manner of rendering leather impermeable to water, without diminishing its strength or its suppleness, and without sensibly augmenting its price. M. St. Real shews that skins may be tanned in such a way as to give this desirable quality to the leather, and in other respects with benefit to the tanner, by reducing all the processes of the art to the following.

For strong ox or cow leather, which is used for making the outer soles of shoes and boots.

1st, Soak the green hides, separate from each other, in
U running

running water, a sufficient time to extract all the soluble animal matter or lymph; it will be easy to determine when that is done, by putting a piece of the hide into water, and heating the water gradually; if no scum is formed upon the surface, it is a proof that no lymph remains.

2dly, Place the hides (after they have been washed and cleaned) in a cauldron, similar in construction to those in which common falt is made; fill the cauldron with water, which is to be heated to 167 degrees of Fahrenheit, and no more: after the hides have been one hour exposed to this degree of heat, take them out.

3dly, Stretch them upon the horse, and proceed to take off the hair in the usual manner.

4thly, Put them again into the cauldron (which should be so contrived that it may receive as much water from a cock on one side as is let out from a cock on the other side), and so keep up in this cauldron a constant current of water, of the heat of 60 degrees.

5thly, Let the hides remain in this cauldron till the water no longer contains any animal jelly; which may be easily known by evaporating a small quantity of it.

6thly, Take the hides out of the water and place them upon the horse, that the cellular and muscular membrane may be taken off.

7thly, Wash the hides again in running water, then put them again into the cauldron, or one similar to it, which is to be filled with filtered tan-liquor. This liquor is to have the same degree of heat that the water had in the former operation; the skins to remain in it till they are completely tanned, taking care to put fresh tan-liquor in the place of that which shall appear to have lost its energy by the combination of its astringent principle with the hides; this may be readily known by dropping in a few drops of a solution of green vitriol.

The author states, that leather made according to this system would be more free than any other from the animal jelly, which is not combined with the tan, and consequently would be less susceptible of moisture. The fibrous part of the skin being more strongly acted upon by the tan-liquor when heated, would become more firm and more difficult to be penetrated by water; it would be increased in strength and compactness, without losing any part of its suppleness.

That excellent Swedish leather so superior to all other, of which boots, breeches, and great-coats are made, is capable of resisting the most violent rains. This leather is prepared in Jutland with hot water.

In the common way the tanner contents himself, before he delivers the leather to the shoe-maker, with beating those parts which are soft, or which have a very irregular surface, upon a smooth log of wood with a mallet. The more careful tanners beat all their hides; and this practice is general in England.

Besides the strong sole-leather already mentioned, leather of a different kind is used in a great variety of arts and manufactures. It is made of skins of cows and oxen, but more generally of calves'-skins; it serves to make the soles of pumps, or women's shoes; for belts, harnesses, covering trunks, &c. or the inner soles of men's shoes, and the upper-leathers; in short, any kind of work in which the thickest and strongest leather is not required. All this sort of leather is carried, because leather as it comes out of the pits is by no means fit for the various uses for which it is intended: it is rough, of an unequal thickness, and unmanageable. The object of the currier's art is to supple it, and to give it an uniform compactness and density; this object he fulfils by the following operations:

1st, He treads the skins, that is, after having soaked them till they are softened, he kneads them with his feet, to make the water penetrate every part equally.

2dly, He works them with the pummel; this is done by applying to the skins a square tool made of hard wood, about a foot long and five inches broad; it is furrowed longitudinally, and convex at the bottom and flat at top; it is fixed to the workman's hand by a leather strap so that it cannot slip. This tool by being worked forcibly along both sides of the skin, first upon the side of the epidermis, and then on that of the flesh, forms the grain of the leather, and gives it suppleness.

3dly, He then works the skin with an iron instrument with a blunt edge; with this he scrapes very strongly those parts which are too thick, those in which there is left any flesh, or any tan, and those in which there are hollows; driving as it were to press the superfluities of the thick parts into those which are too thin, and thus to give to every part of the skin an equal thickness and an uniform density.

4thly, He pares the skin with a paring-knife; this paring-knife is circular: the workman cuts away those thick and projecting parts which the operation just described was not able to remove; so that this last operation may be considered as completing the object of the preceding one.

After the four operations above-mentioned, the leather is supple and smooth, and of an equal thickness and density in all its parts: it is now in a state capable of being employed by the workmen who make use of it. But the very operations which give it these valuable properties appear to injure its compactness. The leather by being beat, stretched, and scraped, must necessarily become more spongy, and consequently more permeable to water. To remedy this inconvenience, the currier impregnates it with fat or oil.

To dress leather with fat, it must first be made perfectly dry. The pores of the leather are then dilated, by passing it over a clear strong fire, and it is rubbed over with a kind of woollen mop dipped in melted fat, pretty hot. The fat thus applied to each side of the leather penetrates into its substance, lodges within its pores, and adhering there fills them up so as to preclude the entrance of any moisture; should the leather be wet when the fat is applied, it will remain upon the surface, and not penetrate into the substance.

The manner of dressing leather with oil is the reverse of this, and is founded upon the property which water possesses of swelling those supple and elastic capillary tubes into which it insinuates itself; also that of its not being miscible with oil, and upon that of its evaporating much more speedily than oil.

The currier therefore soaks those skins in water which he means to dress with oil, and while they are yet wet, he spreads over them with a wool mop any kind of fish oil. As the water evaporates, the oil takes its place; and consequently the more the skins were swelled with water, the more thoroughly they become impregnated with oil.

M. St. Real found the cow-leather dressed with fat imbibes more water than the calf-skin dressed with oil; but he attributes this difference to the manner in which the currier applies the fat. He rubs the leather with a kind of mop, dipped into melted fat moderately warm, it seems impossible that, by this manner of applying it, the fat can penetrate into the interior parts of the leather; the air contained in its pores opposes an invincible obstacle to the penetration of it. On the contrary, there is no air in the pores of the wet leather upon which the oil is applied, and the permanent fluidity

WATER-PROOF.

fluidity of the oil itself also facilitates its passage into the leather.

To make the leather imbibe the fat, he proposes three or four days immersion in running water, to drive out the air; then to soak the leather in melted fat, of the temperature of 167 degrees of Fahrenheit, till all the water in the leather is evaporated by the heat; the fat would then penetrate into the interior pores of the leather, and render it impermeable to water.

If leather is compressed, it evidently diminishes the thickness, and increases its compactness; and if it is beaten with an iron hammer upon a very smooth anvil, it produces a permanent contraction of its pores. Leather is in that respect very much like iron, and all other metals which harden by beating; and, consequently, our author suggests that it would be of great advantage to compress the leather before it is used, by passing it between a pair of rollers, such as are used to flatten metal: this would stiffen the leather.

It appears from experiment that the strong sole-leather, by being properly impregnated with fat, and compressed in the rollers, absorbs only one-thirteenth part of water, imbibed by the same leather which has not undergone those operations. The quantity of water which the first absorbs, and which amounts to about one-thirtieth part of its weight, is so small, that it does not render it capable of wetting any substance it may come in contact with, nor does the leather appear wet when taken out of the water; it may therefore be considered as almost impermeable to it.

The cow-leather, when impregnated with fat, and compressed, absorbs about one-ninth part of the water absorbed by leather of the same nature which has not undergone those operations. The quantity of water absorbed by the first amounts only to the thirty-fourth part of its own weight.

The calf-skin, when impregnated with fat and compressed, absorbs only one-third part the quantity of water that the same quantity of leather absorbs when it has not undergone those operations; and that quantity is not so much as one-fortieth part of the weight of the leather.

In this manner, without making any alteration in the usual method of tanning, except with respect to the thin sole-leather, it is possible to render leather very nearly impermeable to water, by the known operations of currying, provided to them are added compression by rollers, and soaking in fat, as before described. The additional greasing and pressing will not sensibly increase the price of the leather, for it retains only about the sixteenth part of its weight of fat.

The leather which had passed through the rollers was not diminished in its strength; for it supported, without breaking, weights as heavy as were supported by leather of the same kind which had not undergone that operation.

In 1794 Mr. Bellamy of London obtained a patent for a method of rendering leather water-proof, which he thus describes.

Take nut oil, one gallon; poppy-oil, one gallon; and linseed-oil, two gallons; or they may be in other proportions: put them into an iron vessel, and set it over a gentle fire. To every gallon of the mixed oils, put half a pound of amber, or white copperas, sugar of lead, colcothar, or any other proper drier, but observing to use a larger proportion than the above, when the oil is to be prepared for new leather, or a lesser proportion when it is to be prepared for old.

Let the oils remain on the fire, and give it as great a degree of heat as it can bear without burning, or causing it to

rife, for six or seven hours; and if it will not dry sufficiently continue the same degree of heat till it does: then take it off the fire, and when it is a little cooled, it is ready to be applied to make water proof leather.

This is done by a brush being dipped into the prepared matter, and rubbed or brushed into the leather.

When the article is well filled with the prepared oils, lay it on an even board, and scrape off what is superfluous with a thin iron tool; then put it to dry in a warm room, and when sufficiently dry it will be fit for use.

For sole-leather of thick substance, let it be gently warmed, and with a brush or pad, made of wool or hair, rub or brush the prepared matter on the leather, till it is thoroughly saturated; then let it dry in a warm place, and it is ready for use.

The proportion of the mixtures of oils, must be varied according to the nature of the oil, and also according to the nature of the leather, for the same kind of oil will not always have the same qualities.

Oils expressed at different times will frequently have a greater or less propensity to finish; and must, on that account, have more or less of the poppy or nut oils. If the drying oil finishes reluctantly, there must be added a lesser quantity, or none at all, of the nut or poppy oils, and a small quantity of an essential oil added, till it will finish with ease and beauty. The same kind of leather will also require a different mode of treatment; for if the leather be new it will abound more with the natural grease of the animal which produced it, and it will require the oil to be so managed as to absorb or neutralize the greasy quality, that it may finish without loading the leather, and making it unpleasant to the wearer. When this is the case, one-fourth part of essential oil of turpentine must be mixed with the above oils when prepared; and *vice versa* if the leather is old.

Another of Mr. Bellamy's receipts is as follows: to one gallon of the above prepared oils add one pound of gum resin, half a pound of pitch, a quarter of a pound of tar, and a quarter of a pound of turpentine. Let them be well incorporated with the oils, by first heating the whole mass gently, and then increase the fire till the whole is thoroughly mixed; or he proposes to add to the oils, gums sandarach, mastic, anime, copal, amber, together or separate, or asphaltum, or one-sixth part of bee's-wax. In short, any bituminous, resinous, or adhesive matter, which will resist acids, alkalies, and water, and will unite with drying oils, provided when mixed in proper proportions they do not render the leather hard, or make it crack, or otherwise disagreeable.

In the *Annales de Chemie*, Mr. Hildebrand of St. Peterburgh proposes the three following methods of rendering sole-leather impermeable by water.

The first preparation is made by boiling $1\frac{1}{2}$ lb. of minium with 20 lbs. of oil of linseed, or hemp-feed; continue the boiling till the metallic oxyd be entirely dissolved, and the mixture assumes a carbonaceous dark brown colour: apply this composition to the inside of the hides till they can absorb no more of it; then dry them, in summer by the heat of the sun, in winter before a fire. When the composition becomes too thick, it may be liquified by the addition of oil of turpentine.

The second preparation is simply either of the same oils, in part dishydrogenated by fire; it will serve equally well for upper leathers.

The third preparation is a mixture of two ounces of black pitch with a pound of tar, melted together by a gentle heat;

the leather is then anointed with the mixture, and dried. Soles thus prepared ought to be used with the smooth side inwards.

Another receipt for an elastic water-proof varnish is, gum asphaltum, two pounds; amber, half a pound; gum benzoin, six ounces; linseed-oil, two pounds; spirits of turpentine, eight pounds; and lamp-black, half a pound; united together in an earthen vessel over a gentle fire.

The leather is to be nailed on a board, and the varnish applied upon it; it is then to be passed into an oven several times, the varnishing being each time repeated, till the leather is completely covered.

Mr. William Baynham took a patent in 1816 for a water-proof varnish, which very much resembles those of his predecessors. It is prepared as follows: six gallons of linseed oil, one pound and a half of rosin, and four pounds and a half of red litharge, or any other substance usually known under the denomination of dryers, are to be boiled together till they acquire sufficient consistence to adhere to the fingers, and draw out into strings when cooled upon a piece of glass or otherwise. It is then to be removed from the fire, and when sufficiently cooled, thinned to about the consistence of sweet oil, by adding spirits of turpentine to it, which generally requires about six gallons. It is left to settle for a day or two, and then carefully poured off from the grounds; and about one pound and a half of ivory or lamp-black, and one pound and a half of Prussian blue ground in linseed oil, added to and intimately mixed with it. It is then ready for use.

To apply this varnish, stir it up, and lay it on with a brush until it lies on the surface of the leather with an even gloss; then hang up the article which has been operated upon until the next day: repeat the application as before, taking care to leave the surface as thin and even as possible. This must be repeated each successive day, until it has the desired appearance.

WATER, Raising, in Rural Economy. See RAIT.

WATER-Rocket. See ROCKET.

WATER-Sail, in a Ship, denotes a small sail, spread occasionally under the lower studding-sail, or driver-boom, in a fair wind, and smooth sea.

WATER-Scape, of the Saxon waterschap, denotes an aqueduct, drain, or passage for water.

WATER-Shield. See HYDRASPI.

WATER-Shoot, a young sprig, which springs out of the root or stock of a tree.

WATER-Shot, in Sea Language. See MOORING.

WATER-Spout. See WATER-SPOUT.

WATER-Table, in Architecture, is a sort of ledge, left in stone or brick walls, about eighteen or twenty inches from the ground; from which place the thickness of the wall begins to abate. See WALL.

WATER-Thermometer, a thermometer made with water by Mr. Dalton, for the purpose of ascertaining the precise degree of cold at which water ceases to be farther condensed; and likewise how much it expands in cooling below that degree to the temperature of freezing, or 32° . With this view he took a thermometer tube, such as would have given a scale of ten inches with mercury from 32° to 212° , and filled it with pure water. He then graduated it by an accurate mercurial thermometer, putting them together in a basin filled with water of various degrees of heat, and stirring it occasionally: as it is well known that water does not expand in proportion to its heat, it does not therefore afford a thermometric scale of equal parts, like quicksilver.

From repeated trials agreeing in the result, he found that

the water-thermometer is at the lowest point of the scale it is capable of, that is, water is of the greatest density at $42\frac{1}{2}^{\circ}$ of the mercurial thermometer. From 41° to 44° inclusively, the variation is so small as to be just perceptible on the scale; but above or below those degrees, the expansion has an increasing ratio, and at 32° it amounts to $\frac{1}{8}$ th of an inch, or about $\frac{1}{16}$ th part of the whole expansion, from $42\frac{1}{2}^{\circ}$ to 212° , or boiling heat. During the investigation of this subject, his attention was arrested by the circumstance, that the expansion of water was the same for any number of degrees from the point of greatest condensation, no matter whether above or below it: thus he found that 32° , which are $10\frac{1}{2}^{\circ}$ below the point of greatest density, agreed exactly with 53° , which are $10\frac{1}{2}^{\circ}$ above the said point; and so did all the intermediate degrees on both sides. Consequently, when the water-thermometer stood at 53° , it was impossible to say, without a knowledge of other circumstances, whether its temperature was really 53° or 32° . Our ingenious author, recollecting some experiments of Dr. Blagden in the Philosophical Transactions, from which it appears that water was cooled down to 21° or 22° without freezing, was curious to see how far this law of expansion would continue below the freezing point, previously to the congelation of the water, and therefore ventured to put his water-thermometer into a mixture of snow and salt, about 25° below the freezing point, expecting the bulb to be burst when the sudden congelation took place. After taking it out of a mixture of snow and water, where it stood at 32° , (that is, 53° per scale,) he immersed it into the cold mixture, when it rose, at first slowly, but increasing in velocity, it passed 60° , 70° , and was going up towards 80° , when he took it out to see if there was any ice in the bulb; but it remained perfectly transparent: he immersed it again, and raised it 75° per scale, when in an instant it darted up to 128° , and that moment taking it out, the bulb appeared white and opaque, the water within being frozen: fortunately it was not burst; and the liquid which was raised thus to the top of the scale was not thrown out, though the tube was unsealed. Upon applying the hand, the ice was melted, and the liquid resumed its station. This experiment was repeated and varied, at the expence of several thermometer bulbs, and it appeared that water may be cooled down in such circumstances, not only to 21° , but 5° or 6° , without freezing; and that the law of expansion above-mentioned obtains in every part of the scale from $42\frac{1}{2}^{\circ}$ to 10° , or below, so that the density of water at 10° is equal to the density at 75° .

WATER-Tight, in Sea-Language, the state of a ship when not leaky.

WATER-Tracing Crescent, in Rural Economy, the tool formed in the manner of the gardener's edging-iron, but made much larger, and in the crescent form, very thin and well-steeled, and sharp in the edge, having a stem about three feet in length, with a cross handle for bearing upon in working with it, in cutting out the sides of the different conductors of the water in watering land. See WATERING Land.

WATER-Ways, in Ship-Building, the side-strake of a deck wrought next the timbers, and much thicker than the deck, but reduced to the thickness of the deck in front: it makes a channel for the water to run through the scuppers, and prevent leaking at the side.

WATER-Wheel, an engine for raising water in great quantity out of a deep well. See PERSIAN-Wheel, and WATER, Raising of, supra.

WATER-Workers, in Agriculture, a term applied to the makers and formers of meadow-drains and trenches, or wet ditches.

ditches, as in the practices of watering and draining of land, or otherwise.

WATER-Worm, *Reproduction of*, in *Natural History*. See *REPRODUCTION*, and *Water-Worm*. See also *VERMES*.

WATER Key, in *Geography*, a small island in the bay of Honduras, near the coast of Mexico. N. lat. $17^{\circ} 30'$. W. long. $88^{\circ} 40'$.

WATER Key, a small island in the Spanish Main, near the Mosquito shore. N. lat. $12^{\circ} 15'$. W. long. $82^{\circ} 55'$.

WATER Key, South, a small island in the bay of Honduras. N. lat. $16^{\circ} 35'$. W. long. $88^{\circ} 45'$.

WATER Point, a cape on the east coast of Java. S. lat. $7^{\circ} 55'$. E. long. $114^{\circ} 33'$.

WATER Sound, a strait of the North sea, between South Ronaldsha and Barra, two of the Orkney islands.

WATERBOROUGH, a town in the district of Maine, and county of York, containing 1395 inhabitants; 15 miles N.W. of Wells.

WATERBURY, a town of the state of Connecticut, containing 2874 inhabitants; 20 miles S.W. of Hartford.

WATEREE, a river which rises in the Allegany Mountains, then runs southerly into South Carolina, and changing its name to Wateree; after a course of about 120 miles, it joins the Cangaree, and then takes the name of Santee.

WATERFORD, a maritime county of Ireland, in the province of Munster, having the county of Cork on the west, the counties of Tipperary and Kilkenny on the north, the county of Wexford on the east, and St. George's Channel on the south. It extends from east to west 40 Irish, or 51 English miles; and from north to south 23 Irish, or 29 English miles. Its breadth, however, varies much, and is in one part not more than six miles. The area is stated to be 262,800 acres, or 410 square miles Irish, which are equal to 425,692 acres, or 665 square miles English. Dr. Beaufort states the number of houses to be 18,796; and the number of inhabitants at least 110,000. The number of parishes is 74, in which there were 21 churches, divided between the sees of Waterford and Lismore. Waterford returns four members to the imperial parliament, two for the county, one for the city of Waterford, and one for the borough of Dungarvan. The county of Waterford is in general hilly, and the northern part is particularly rough and mountainous; in the south and east the soil is rich and productive. In the west of the county, on the north of the Blackwater, there is a ridge called the *Knockmeledown* mountains, many parts of which are very high, though Mr. Twiss is mistaken in calling them the highest in Ireland. The Comeragh mountains cover a great extent of country between Dungarvan and Clonmell. These hills, except in a few desolate and craggy spots, afford pasture to small cows, which produce a great quantity of butter. In the eastern part agriculture has been much improved, and the farms are not surpassed in any part of Ireland.

The river Blackwater flows through the west of this county into the bay of Youghal, and is navigable to Cappoquin. The banks of this river are peculiarly beautiful, especially near Lismore. The river Bride, which joins the Blackwater, passes near the town of Tallow, and is so far navigable for large boats. The gentle and majestic Suir forms the northern boundary, dividing it from the counties of Tipperary and Kilkenny, and running east till joined by the Barrow; when, turning south, they form an estuary, 9 miles long, and 2 broad, which is the harbour of Waterford. At Dunmore, near the extremity of this, on the Waterford side, a very fine pier is building, for the protection of the packets, and of such vessels as may put into this harbour.

Dr. Charles Smith published "The ancient and present State of the County and City of Waterford," in the year 1745, which was reprinted in 1772. In this work, he states the Menapii to have been inhabitants of this county and Wexford in the time of Ptolemy, which Menapii he supposes to have been a colony from the Belgic Menapii, mentioned by Cæsar. The Desii are stated to have been a powerful clan at the time of the English invasion. These came from the county of Meath, and gave name to the baronies of Desies within and Desies without Drum, and their descendants are now called Deasy. Though the power of the Desii was abolished by the English, yet, for many years after, the O'Feolains, kings of the Desii, are occasionally mentioned in the Irish annals. Henry II. in 1177 made a grant of the city of Waterford, with all the circumjacent province, to Robert Le Poer, his marshal, from whom are descended not only the family of Le Poer, the head of which was created, in 1535, earl of Tyrone, but also the several respectable families of Power, settled at Clashmore, Gurteen, &c. By marriage, the estates and honours of the Le Poers came to the family of Beresford, the head of which is now marquis of Waterford, and has a noble seat at Curraghmore, in this county. In the civil war, Waterford had its share of disturbance, and Cromwell himself was engaged unsuccessfully in the siege of its capital. Dr. Smith's Topography is still interesting to the reader, from the various information he collected respecting the different families settled, though many of them are now extinct or removed. His natural history is very defective, yet it is the best hitherto published. He drew attention to the fisheries, and to the Nymph bank, yet even now, though employment is so much wanted, the fisheries remain without encouragement. In his enumeration of eminent men born in this county, we find the names of Congreve the poet, and of Robert Boyle, who was born in the castle of Lismore. The duke of Devonshire, as descendant of the eldest branch of the Boyle family, possesses the towns of Dungarvan, Lismore, and Tallow, with a great tract of land, which gives him a preponderating influence in the county. Beaufort's Memoir of Ireland, &c.

WATERFORD, a city and sea-port town on the south side of the river Suir, in Ireland, capital of the county of the same name. This river is embanked by a noble quay, extending the whole length of the town, to which vessels of great burden can come up, though the largest ships generally lie a few miles lower down. Like most of the other sea-ports of Ireland, it was originally built by the Ostmen or Danes; and is said to have been founded A.D. 853, nearly at the same time as Dublin and Limerick. Waterford seems to have been the chief settlement of this people, for we find the kings of the Danes of Waterford often mentioned in the old annals. Strongbow, soon after his landing in Ireland, took Waterford by assault in 1171, and in 1172 he gave it up to king Henry II., who landed at Waterford, and received there the submission, not only of his English subjects, but also of many Irish chiefs. King John also landed at this city, and made it his residence for some months. The steady adherence of Waterford to the English caused it to be engaged in almost constant warfare with its neighbours; and in return it received many marks of royal favour. Richard II. landed twice at Waterford. When Simnel was crowned king by the earl of Kildare, the lord deputy, the citizens of Waterford refused to admit him, adhering steadily to Henry VII., in consequence of which he addressed a letter to them, thanking them for their adherence, and giving them power to seize the rebels and their effects, and to employ the latter for their own advantage. They behaved with the same loyalty against Perkin

Warbeck,

Warbeck, who had many adherents in Ireland, in consequence of which the king gave them this motto, which is still used, "Intacta manet Waterfordia." In the reign of James I., Waterford appears to have become turbulent in consequence of its attachment to the Roman Catholic religion, and in consequence was deprived of many privileges, but these were restored by Charles I. In the civil war, Waterford was on the side of the Catholics, and a meeting of the popish clergy was held there by the pope's nuncio in 1646. It was besieged by Cromwell without success; but was afterwards taken by Ireton. It has been already mentioned that Waterford was built by the Danes; it was at first called *Portlargo*, from *laarge*, a thigh; the course of the river Suir, near this place, resembling that part of the human body. The English gave it its present name, as it is said, from a ford in St. John's river, which empties itself into the Suir. The city chiefly faces the north and east, which, though seemingly a situation not so desirable, being exposed to the chilling blasts of these winds, yet the healthiness of it makes amends for the bleakness of the exposure. A further advantage is its noble situation, near the confluence of three large and navigable rivers, the Suir, the Nore, and the Barrow, by which inland commodities may be supplied at a very inconsiderable expence of carriage, from the very centre of the island, and from seven different counties washed by these rivers, and other counties adjacent to them. Over the river Suir, a fine wooden bridge has been erected within a few years, to facilitate the communication with other places. A very flourishing commerce with England and other countries is the happy consequence of such a situation. Its exports of beef, butter, hides, tallow, pork, and corn, are considerable. The number of large hogs weekly slaughtered during the season exceeds 3000 on an average. The quantity of butter annually exported exceeds 80,000 casks.

This city is also largely concerned in the Newfoundland trade. The population is supposed to exceed 40,000, and it ranks as the fourth town of Ireland in extent, and the fifth in commercial importance. Packet-boats are established between this port and Milford Haven, for the convenient intercourse of the south of Ireland with England. This city sends one member to the united parliament, elected by the freemen and freeholders. This election is free, and, to the honour of the electors, sir John Newport, one of the most steady friends of Ireland, has been repeatedly returned. The cathedral of Waterford, adorned with an elegant steeple, is a fine structure. There is also a very superb Catholic chapel, with several other places of worship. The other public edifices are constructed with much elegance, and essentially contribute to ornament the city. It is, however, of more consequence to observe, that its numerous charitable institutions are well conducted, and liberally supported. Its house of industry may serve as a model for others. Its fever hospital was the first in Ireland, and nearly the first in the united kingdom, and has been carried on with uniform success. Without any wish to take from the merit of other worthy individuals, much of this praise is due to the exertions of the *Society of Friends*, who are numerous in Waterford. This city is $74\frac{1}{2}$ Irish miles S.S.W. from Dublin. Smith's Waterford. Carlisle's Dictionary. Wakefield, &c.

WATERFORD and **LISMORE**, *Bishopric of*. The first of these sees, which is confined to the eastern part of the county of Waterford, and is very small, was founded by the O'ftmen in the 11th century; but that of Lismore, which includes the greatest part of Waterford county, and a considerable portion of Tipperary, was founded in the seventh

century. The union took place in 1536. The extent of the union is, in Irish miles, 39 by 29, and in English 49 by 37. The number of Irish acres 354,800, which are divided into 106 parishes. Forty-four of these are inappropriate, and the rest form only 44 benefices, of which, when Dr. Beaufort published his account, only 30 had churches, and only 8 glebe-houses. Many churches and glebe-houses have been built throughout Ireland within a few years. Beaufort.

WATERFORD, a populous and compact incorporated post-village, in the S.E. corner of Half Moon, Saratoga county, on the W. bank of the Hudson; 10 miles N. of Albany. It is the most populous town in the county, and has the greatest share of trade. It is handsomely laid out, in 5 E. and W. streets, intersecting at right angles. It has 190 houses and stores, 2 houses of worship, and some other buildings, together with three schools on the Lancaster plain. It is well situated for a manufacturing town; and in 1812 a wharf, 320 yards long, was constructed, and a canal along it to the channel of the Hudson.

WATERFORD, a town of the state of Vermont, in the county of Caledonia, on the W. bank of the Connecticut, formerly called Littleton, containing 1289 inhabitants; 40 miles N. of Norwich.

WATERFORD, a post-town in the district of Maine, and county of Oxford, containing 188 inhabitants; 95 miles N. of York.

WATERFORD, a post-town of Virginia; 20 miles N.W. of Washington.

WATERFORD, a town of Connecticut, in the county of New London; containing 2185 inhabitants.

WATERFORD, or *Le Beuf*, a post-town of the state of Pennsylvania, in the county of Erie, containing 162 inhabitants; 370 miles N.W. of Washington.

WATERFORD, a township of New Jersey, in Gloucester county, containing 2105 inhabitants; 40 miles S. of Trenton.—Also, a town of Ohio, in the county of Washington, containing 701 inhabitants.

WATERGUCHEE, or **WATERQUECHIE**, a river of Vermont, which runs into the Connecticut, N. lat. $43^{\circ} 34'$. W. long. $72^{\circ} 18'$.

WATERING, in *Gardening*, the practice or means of rendering seeds, plants, shrubs, and trees, as well as garden-grounds, properly and suitably moist for the purpose of their better, more ready, and more healthy germination, growth, and taking root, when sown, planted out, or set, and afterwards for continuing them in the necessary states of vegetation, growth, and increase, especially when the weather is dry, hot, and parching. It is also occasionally useful in preventing some sorts of fruit-trees from being destroyed by the attacks of different sorts of insects, as well as for the clearing them of other kinds. It is occasionally equally essential for the seeds and plants in the full ground, as for those in pots in it, and those in green-houses, glass-cases, hot-beds, hot-houses, stoves, and other similar situations; such, for instance, in the former kinds, as the seeds in drills, beds, and other open places, different young plants in the same situations, numerous others of the cutting, slip, offset, and other similar kinds, which have been newly pricked out, planted, or transplanted, not only at the time of first putting them out, but now and then afterwards, when dry hot weather is present; also in many kinds of newly-planted young trees and shrubs in the spring and early autumnal plantings; and to all the plants which are in pots in the open air, whether they may be of the more or less hardy kinds, during the droughty seasons of spring, summer, and early autumn; and in the latter description, to all the fine tender kinds

kinds of potted plants and trees under any sort of covering or protection of the house or other kind.

There are many sorts of plants which cannot exist without watering in either a small or plentiful manner. Some stand in need of it only in a slight degree, and at particular seasons of the year, while others demand it in very full proportions at all times. Some are very nice in the quantities which are required at any one time; but others are less particular in this respect. Some too are under the necessity of having it thrown over their leaves as well as to their roots; others only have occasion for it to the root part. And there are some other methods of administering and applying it, which are peculiar to certain kinds of plants, trees, and other vegetable products, as shewn under their particular individual modes of culture.

In all cases, the most proper water for this use is that which is contained in any sort of pond, reservoir, or other similar kind of excavation, for the purpose of containing it in a state of constant exposure to the atmosphere, in gardens or other places, as it is not only more convenient and ready for being employed, but, at the same time, a great deal more salutary, and better adapted to promote the growth and increase of the different sorts of plants and vegetables, than that of the raw, sharp, cold, hard kind, which is drawn from wells or raised by pumps for immediate use, as being more soft in its nature, and more suitable in its temperature.

The most suitable time of applying it is in the evening, after the disappearance of the sun, and when the excessive heat of the day is gone off, and in a great measure abated, as its effects are then more beneficial and lasting; and besides the work can be performed with more ease and convenience, as well as in a more agreeable manner.

When once the business of watering has been commenced, it should always be regularly proceeded with, or the plants or vegetables may suffer much, and be greatly injured by the omission or neglect. It is constantly better never to attempt it, than to just begin and then leave it off again, as is much too frequently the case, in the practice of horticulture, with some gardeners, who have not fully considered the matter.

The work of watering seeds, plants, shrubs, and trees, is usually performed, either by means of common watering pots and cans, large syringes contrived for the purpose, forcing engines for throwing it up over the plants, or by some other contrivance of a similar nature. The water being mostly brought to the places where it is wanted, either in tubs hung in a sort of barrow-frame, or by their being placed on the barrows themselves.

The water is commonly applied in a fine divided state, over the plants, where it is not required in any large quantities, and for clearing away and destroying smuts: but where it is demanded in large proportions, it is often poured in full streams to their roots or other parts.

But in using it upon a large scale for garden-grounds, Mr. London has suggested that it may be accomplished by a practice somewhat similar to that of overflowing tillage-land, or by means of subflooding; this last may, he thinks, be effected by having a stratum or layer of gravel underneath the whole garden, which by having a trench surround it, or, if upon a slope, at the upper side of it only, may have the ground wholly saturated with the water let into it, which will soon be absorbed and taken up by the incumbent surface containing the vegetables that are under cultivation. And, in the former of these methods, by having pipes, open-cuts, or rather small wooden troughs, which may serve to convey and conduct the water upon the surface of every

quarter of the ground; it may there distribute itself in the intervals between the beds or drills, as well as over the general surface of the broad-cast crops. It is further suggested that the former method could be put in practice at any period of the spring or summer; the latter, for the most part, in moist weather, or in the night season. See *WATERING of Land*.

In the watering of both seeds, plants, and garden grounds, much care should, however, be taken, in every instance, that injury instead of good be not done, by employing too large quantities, or continuing them for too great a length of time.

On the whole, it will be evident, from what has been said above, that the practice of watering in garden culture may be beneficial in different ways, as in exciting and promoting a better and more speedy vegetation in newly-sown seeds and transplanted vegetables; in forwarding the growth and increase in a proper manner of different crops, plants, and trees; and in the destruction or removal of insects, such as the *aphis*, red spider, and some of the *coccus* tribe.

WATERING-Barrow, in *Gardening*, such as is employed in conveying water to gardens or other places. They have usually a tub fixed upright in the frame by means of pivots, hooks, and gudgeons, or some other way, one-half of which is below and the other above it, the water being, in a great measure, prevented from spilling while it is carrying. See *QUENDON Water-Barrow*.

WATERING Forcing-Engine, an engine contrived for the purpose of forcing water in a sort of shower over some kinds of fruit-trees, garden vegetables, and plants, and which commonly effects the business in an easy, convenient, and effectual even manner, being well adapted to particular modes and purposes of watering.

WATERING of Land, in *Agriculture*, the practice of overflowing it artificially in the grass state, with the water which is diverted from an adjoining or neighbouring river or stream, which has a higher level than the ground to be covered, or where there is a proper fall. In this way, by the new-formed water-courses being kept nearly on the level, the spaces of land between the new and the old channels may be watered, the water being brought upon the ground by the former, and discharged or taken away by the latter; and thus a constant succession of the water be retained and removed without such an accumulation of it as would be injurious, or such a deficiency as would leave any part imperfectly supplied. In different districts different names are applied to this practice, such as those of floating, flooding, drowning, foaking, and some others.

It is, without doubt, a practice of great antiquity, which it is probable the extraordinary fertility afforded by the annual overflowings of the river Nile, in Egypt, may have first suggested as the means of improving the lands of other countries. In this country, indeed, it would seem to have been had recourse to, for the purpose, at a very early period, as in the county of Hereford, it appears to have been practised more than two hundred years ago, as is evident from a work on the subject written by Rowland Vaughan, and published in the year 1610, entitled "Most improved and long-experienced Water-Works; containing the manner of summer and winter drowning of meadow and pasture, by the advantage of the least river, brook, fount, or water-mill adjacent; thereby to make those grounds, especially if they be dry, more fertile ten for one." And the practice is probably still more ancient in the county of Wilts than in the above or any other district, in consequence of its possessing naturally watered grass lands, which perhaps first led

to the notion of forming them in an artificial manner. The general want of good pasture-grounds in the high lands of this county might, it has been supposed, be a great inducement to improve such watery valley-tracks, which must ever have displayed the most pleasing and interesting appearances of early and luxuriant vegetation and growth.

However, in whatever way the practice originated in this country, it is unquestionably a method that is deserving of the attention of the land proprietor and the farmer in a very high degree.

It has been stated by different writers on the practice of watering land, that the most proper qualities of the grounds for being watered, are all those which are of a sandy or gravelly friable open nature, as on such the improvement is not only immediate, but the effects produced more certain and powerful than on other kinds of them. There are also some strong adhesive four wet lands, which are also capable of being improved by watering.

There are still some other sorts of lands, as those which contain different kinds of coarse vegetable productions upon their surfaces, such as heath, ling, rushes, boggy and other aquatic plants, which may likewise be much improved by watering. It should, however, be constantly kept in mind, in attempting this sort of improvement, that the more stiff and tenacious the soil or land is, the greater the command of water should be, in order to effect the purpose.

The lands which admit of this sort of improvement with the most success and benefit are, for the most part, all such as lie in low situations on the banks and borders of brooks, rivers, and streams, or in sloping directions on the sides of hills, to which water can be conducted in an easy and ready manner.

The writer of a late useful tract on the subject, however, seems inclined to suppose that there are only a few soils or sorts of land to which watering may not be advantageously applied; the experience which he has had, it is said, has determined, that the wettest land may be greatly improved by it, and likewise that it is equally beneficial to that which is dry. But that as many persons, unacquainted with the nature of watering land, may be more inclined to the latter supposition than the former, the reason of wet land being as capable of improvement by watering as that which is completely dry before it is used, is explained. It is that, in the construction of all watered meadows or lands, particular care must be taken to render them perfectly dry when the business of floating or covering them with water shall terminate; and that the season for floating or watering is in the winter and not in the summer, which those who are unacquainted with the process have too commonly supposed. All bogs of the peat kind are certainly, it is said, of vegetable origin, and those vegetables are all aquatic in their nature. It therefore follows that the same water which has produced the vegetables of the bog would, under due management upon the surface, produce such grasses or other vegetables as are usually grown by the farmer; and the writer has hitherto had reason to think, that this may be considered as a general rule for determining the situation for any experiments or trials with water. The writer having succeeded in the attempt to make good watered lands, upon soils which have been thought unfit for the purpose, and floated or watered them with water that was equally condemned, in point of quality, he is now, it is said, sufficiently emboldened to recommend the trial of watering land by means of machinery, and that the most flattering hopes of success are entertained from it. It is noticed that the grasses produced by the first year's floating or watering of a peat-bog, or any wet land, will be much more like what

will become the permanent herbage of a water-meadow, than the first or second year's crop from a newly-floated or watered piece of dry land. The herbage of the former being, it is said, previously stored with aqueous plants, is in some degree suited to this new state, whereas the herbage of dry land is generally of quite a different nature, and often produces an exceeding great crop of grass the first year, which does not appear the next; for the same water which caused these grasses to grow so very luxuriantly the first year, will totally destroy them in the course of the ensuing winter, and produce an herbage much more congenial to that degree or state of moisture. The utility of watering in all these cases has been fully established in several different districts, so that proper examples of the forms and crops may always be readily had for the trials of others in the same way. This has been done, it is said, in the counties of Bedford, Norfolk, and Kent, in the first and last of which upon soils that are very different from those of most water-meadows in the county of Wilts; and that the floating or watering of them has been effected with water which was always before considered to be wholly unfit for that purpose, even by those supposed to be the best acquainted with the practice: it is now, however, fully proved and shewn to be the case, not only by the accurate investigations of the most able chemists, but by the extraordinary growth of grasses in particular boggy situations, that waters of the ferruginous kind are not at all hurtful to vegetation; but, on the contrary, very friendly to it, when they are properly applied. Such facts being established beyond all possibility of doubt, afford, it is said, a much greater scope for the improvements by water, than was ever expected or thought of by the most sanguine advocates of watering, and enables the writer, from his great experience and observation, in different parts of the kingdom, to say that there are few districts to which they are not applicable.

It is, however, supposed by some, that the quality of the water, like that of marl or other manures, is a matter of the first importance, and should be particularly ascertained. And it has been remarked by the author of the "Treatise on Landed Property," that it is universally known that water which flows out of a dung-yard possesses a fertilizing quality. It is generally admitted, too, that the washings of sheep-walks, freshly-manured arable lands, streets of towns, roads, and other such places, after a long drought, have the quality of fertilization. And it is equally evident, it is thought, that the waters issuing in different parts of the kingdom from chalk, lime-stone, marl, or other calcareous stratum, though they are perfectly limpid, possess the power of fertility; and those of some districts, as of Wiltshire, Dorsetshire, and some others, to an astonishing degree. And a similar, though less powerful, effect is produced by the limpid waters, which issue from the slate-rocks of Devonshire and Cornwall. On the other hand, waters that ooze out of peat-bogs, and issue from particular mines, are well known to be injurious to the growth of agricultural vegetables.

It is added, that chemistry points out tests and processes whereby waters, as well as marls and other gross manures, may be tried and analysed. But the virtue of water, when considered as a manure, does not reside in a single principle, like that of lime-stone. Water is capable of suspending, not only calcareous earth, but various other matters,—of animal, vegetable, and fossil origin: some of them friendly, others inimical, to vegetation. It would, therefore, it is thought, be imprudent in a practical man in this business to commit himself to theoretic guidance alone, while the theory of manures, and especially of watering land, remains so much involved

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involved in obscurity; and while trials in the field, on the very land which is desired to be improved, may be made with facility and prompt decision.

The effects of watering are remarkable in many instances: in Wiltshire, it is not uncommon to see, it is said, lands, where water has been diverted for the purpose of improvement, divided by a hedge or a ditch only, the grass on one side of which is of the most luxuriant nature and abundant growth, but on the other so diminutive that the strongest blades have never reached the height of three inches. The same is the case in other situations, which sufficiently marks the importance of the practice.

It will be necessary, before we state the different methods of performing the business of watering in different circumstances, to give some account of the implements which are requisite for the purpose, as well as some explanation of the terms employed in carrying on the work in the different modes. The first and principal instrument in the execution of the work is a proper level, of which the spirit one is perhaps the best. It is necessary for taking the level of the land at a distance, compared with the part of the river or other stream, from whence it is intended to take the water, to know whether it can or cannot be made to float the part designed to be watered. It is particularly useful in works of this sort on a large scale, though the labourers too frequently neglect the use of it, bringing the water after them to work by in-cutting the several parts that are to convey the water. It should, however, be mostly used as being more certain and correct. See *LEVEL*, and *WATER-LEVEL*.

A proper line and reel and cutting-iron are likewise absolutely necessary, as well as a breast-plough, which should be of the best kind, as being of great use in cutting turfs for the sides of the channels and other parts. See *WATER-Line and Reel*, *WATER Crescent*, and *BREAST-Plough*.

The spades used in this sort of work should have the stems or handles considerably more crooked than those in common use, the bit being of iron, about a foot in width, in the middle, terminating in a point, a thick ridge running down the middle part, from the top to near the point; the edges on both sides being drawn very thin, and kept quite sharp by frequent grinding and whetting: when they are become thin and narrow by wearing, they are used for the smaller trenches and drains. By means of the handles being made so crooked, the workman, standing in the working position in the bottom of the drain or trench, is enabled to make it perfectly smooth and even without any difficulty.

Both short and narrow scythes are also necessary, in order to mow and cut away any weeds or superfluous grass that may be present, during the running of the water in the trenches or other cuts; as well as forks, and long four or five-tined crooks or drags for pulling out the roots of the sedges, rushes, reeds, and other such matters, that may be in the large mains or other channels. These crooks should be made light, and have long shafts to reach wherever the water is so deep that the labourers cannot work in it, so as to remove such obstructions.

Wheel and hand-barrows, too, become necessary and useful, the former for removing the clods and earths to the flat or hollow places, for this use they may be made open, without sides or hinder parts; the latter are used where the ground is too soft to admit the former, and where the clods or other matters require to be removed during the time the land is in water. But when large quantities of earth are wanted to be removed, especially when to be conveyed to some distance, three-wheeled carts are proper.

And in all cases a stout large water-proof pair of boots is

absolutely requisite, having the tops made so as to draw up half the length of the thigh; they should be large enough to admit a quantity of hay or other such materials to be stuffed down all round the legs, and be kept well tallowed, in order to resist the running water for any length of time.

The terms used in the practice of watering are very numerous. A weir is a work thrown over or across a brook, river, rivulet, stream, main, or other such parts, the use of which is to divert the water; and when the hatches are all properly adjusted and in their places, to stop the whole current, in order that the water may rise high enough to overflow the banks, and spread over the adjoining land; or, by stopping the water in its natural course, turn it through mains or channels, cut to convey it another way, to some distant lands that are to be watered. See *WEIR*.

A sluice differs from the above simply in having but one thorough or opening, as when there are more than one it becomes a weir. It is applicable in small streams in the same way that the weir is in large ones. See *SLUICE*.

The covered sluice or trunk is constructed and had recourse to in all such cases, as where two streams of water are to cross each other at the point of discharge, and to serve as a bridge. The drain-sluice or trunk is that which is placed in the lowest part of a main, as near to the head as it can be formed, and put low enough to drain the main and other parts. It is put with the mouth at the bottom of the main, being let down into the bank; and from the other end of which a drain is cut to communicate with some trench-drain that is the nearest. It is used for carrying off the leakage through the hatches when shut down, to convey the water to other grounds, and for some other purposes. See *SLUICE*.

Hatches are flood-gates, and used for the same purposes: they are consequently differently formed in different cases; but such as have about a foot to take off, and let the water pass over so much of them, are thought useful by some in different cases of watering. Others suppose them the best when made whole and of good timber. See *HATCH*.

A carriage is a sort of small wooden or brick passage, built in an open manner, for the purpose of carrying or conveying one stream over another, and is useful in many cases, though very expensive in the practice of watering.

Head-main in watering land implies that part of the principal cut or channel which takes the water first out of a river or stream, and conveys it to such lands as are laid out for the purpose, by means of smaller mains and trenches. It is necessarily formed of various breadths and depths, according to the quantity of land to be watered; and to the length, or the fall of the ground it is cut through. Small mains are the next order of cuts for the distribution of water on lands, as connecting between the head-main and trenches. These smaller mains are mostly taken out of the head-main; and the only difference between them is, the one being much less than the other; they are commonly cut at, or nearly at, right angles with the other, though in some cases at many degrees less. The use of both these sorts of mains is to feed the various trenches and gutters that branch out in all parts of the land with water, and to convey it for floating the ground in an equal manner. By some these smaller mains are termed carriages, but improperly, as it is confounding them with the open trunk so named, as already seen.

The trench, in watering, is a shallow narrow cut or ditch made to take the water out of the mains for floating the land. It should always be drawn in a straight line from angle to angle, with as few turnings as possible. It is

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never made deep, but the width of it must be in proportion to the length it has to run, and the breadth of the pane of ground between that and the trench-drain. It should constantly be cut gradually narrower and narrower, in the wedge-form, to the lower end, in order to force over the water more equally.

The trench-drain is constantly cut parallel to the trench, and as deep as the tail-drain water will permit were necessary. It should always, where possible, be cut so as to come down to a firm stratum of sand, gravel, or clay. If the last, a spade's depth into it will be of great benefit. The use of it is to take away the water immediately after it has run over the panes of the land from the trench. It is not necessary to be brought up to the head of the land by five, six, or more yards, as the nature of the soil may be. The form of it is the reverse of the trench, being narrower at the head, or upper part, and gradually wider and wider, until it comes to the lower end, and empties itself into the tail-drain, which is a receptacle for all the water that comes out of the other drains, that are situated so as not to empty themselves into the river; and, consequently, it should run nearly at right angles with the trenches; but it is, in general, preferable to draw it in the lowest part of the ground, and to use it for conveying the water out of the ground where there is the greatest descent: this is commonly found in one of the fence-ditches; for which reason a fence-ditch is mostly made use of for the purpose, as answering the double use of a fence and drain at the same time.

The pane of ground is that part of the land which lies between the trench and the trench-drain, and is the part on which the grass grows, which is cut for hay: it is watered by the trenches, and laid dry by the trench-drains; consequently there is one on each side of every trench. The term pane is also applied to the part which is used, for taking off the produce.

The bend implies a stoppage made in different parts of such trenches as have a quick descent, in order to obstruct the water. It is effected by leaving a narrow slip of greenward ground across the trench where the bend is designed to be, and cutting occasionally a small part out of the middle of it in the wedge form. It is useful for checking the water, and forcing it over the trench on to the panes; which, if it were not for such bends, would run rapidly on in the trench, and not flow over the land as it passes along. The great art of watering land consists in giving to every part of each pane of ground an equal quantity of water, which is greatly promoted in this way.

The gutter is a small groove cut out from the tails of these trenches, where the panes of ground run longer at one side or corner than the other. The use of it is to carry the water to the extreme point of the panes. Those panes which are intersected by the trench and tail drains, meeting in an obtuse angle, want the assistance of these gutters to convey the water to the longest side. And another use of them is, when the land has not been so perfectly levelled but that some parts of the panes of ground lie higher than they should, a gutter is then drawn from the trench over that high ground, which would otherwise not be overflowed. Without this precaution, unless the flats were filled up, which should always be the case when materials are to be had, the water will not rise upon it; and after the watering-season is past, those places would appear of a rusty-brown, while a rich verdure would overspread the others; and at hay-time the grass in those places would scarcely be high enough for the scythe to touch it; while that around them, which has been properly watered,

will, from its luxuriance, be laid down. This neglect is, therefore, to be reprobated in most cases, as the great art of watering land is that of throwing the water regularly over all parts, those where it cannot rise of itself as well as others, and in carrying it off from those in which it would otherwise stagnate and be hurtful.

The catch-drain is an occasional ditch, sometimes cut for the purpose of carrying the same water into a second main or other part, for watering lower lands or panes of ground with the water that has been before used. It is made use of too in some other cases, as catching the water that is thrown forward.

Pond is used to signify any part where the water stands on the ground in watering, or in the tail-drain, trench-drains, or others, so as to injure the lands near them; and is occasioned by flats and irregularities in the surface of the grounds, as well as by other causes.

The turn of water means the space of land that can be watered at one time in any case; and is accomplished by shutting down the latches in all those weirs where the water is designed to be kept out, and opening those that are to let the water through them. The quantity or extent of land to be watered by one turn, must of course vary with the size of the river, brook, main, and other such parts, and by the plenty or scarcity of the water.

The bed of a river, main, trench, or other such part, is the bottom of any of them.

The head of any watered land is that part into which the river, main, or other such part, first enters. And the tail of it is that part where the water last passes off by the tail-drain into the course that is to take it away.

The upper side of a main or trench is that which, when they are made at nearly right angles with the river or other such part, fronts the place where the river, &c. entered. And, of course, the lower side is the reverse.

The upper pane of the land is that which lies upon the upper side of the main or trench when made at right angles with the river, &c. running north and south. Where, however, these run parallel with the river, &c. the panes on either side are not distinguished from each other.

Some other terms, which are used by the more modern writers on watering land, will be explained as we proceed in pointing out the nature of the business.

After noticing the manner in which water is artificially brought on and taken away from the land in watering, as already seen, the writer of the tract before alluded to remarks, that the art of watering land may properly be called floating, not foaking or drowning. Soaking the soil, similar to the effects produced from a shower of rain, is not sufficient for the general purposes of watering; nor will damming up the water, or keeping it stagnant upon the surface, like that in a pond, or on the fens, produce the desired effect. The latter, it is thought, may properly be termed drowning, because it drowns or covers all the grasses, thereby rendering the plants beneath it certainly aquatic, or the herbage disposed to take on such a change; whereas the herbage of a watered meadow or land should, from the form and circumstances of the ground, enjoy the full benefits of air and water. Practice has proved, it is said, that there is no better method of effecting this, than by keeping the water passing over the surface of the land with a brisk current, but not so brisk as to wash away the soil, and yet in sufficient quantity to cover and nourish the roots, but not too much to hide the shoots of the grasses: hence appears the nicety of adjusting the quantity of water; and hence it appears, too, that one main-drain, to bring the water on the upper side of the land, and another on the lower

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lower side to take it away, will not be adequate to all the purposes of such an accurate regulation. If the space between the upper channel, or *main-feeder*, and the lower one, or *main-drain*, should therefore be wider than what is proper for the due adjustment of the water, that is, so that every part of the space may have enough of water passing over it, and no part too much, then that space must be divided into smaller spaces by intermediate drains, which may catch and re-distribute the water. These, and the ground capable of being watered in this way, have this term applied to them, as they *catch* or collect the water and re-distribute it, being in well-formed lands never made more than eight or ten yards apart. As the water is brought by the main-feeder upon the higher side of a piece of ground, which slopes towards the main-drain, and down which sloping surface the water will very readily run, to persons unacquainted with watering, it does not at first sight appear necessary to make such a number of intermediate catch-drains; but it is proved by experience, that however regular the slope of ground may appear to the eye, the water will find a number of irregularities, force itself into gutters or channels, and defeat the purposes of watering, in the hollow places by excess, and in the high ones by the want of water. Hence the water that was scattered over the surface of the first space, being all collected in the catch-drain, may, by the skill of the floater, be let out upon those parts of the bed of ground below, which seem to need the greatest assistance.

As it is essentially necessary to possess full and complete command of the water in all cases of improvements of this nature, the works for the purpose should always be well-formed at first. Temporary means of making dams and hatches to divert the water out of its usual channel may, it is said, by the writer of the tract on watering land, suffice to try an experiment, or for a tenant who has but a short term in the grounds to be watered; but every land-owner, or other proprietor, who enters upon or undertakes such works in this temporary manner, sadly mistakes his own interest; indeed, it is frequently more difficult to repair than to renew upon large streams, where the foundations are not seldom destroyed or very greatly injured by the force of the water. The same principle holds good upon small streams, and even in the feeders and drains of watered land. Wherever the channels are so contracted as to make a fall, or much increase the rapidity of the stream, it is constantly disposed to wear away the sides of its channel, or undermine a dam. The repair of these defects will stand in need of land to be dug away and wasted each time, they are replaced with the loss of labour. The consequent ill-management of the water renders it more advisable, and perhaps cheaper, to make all such works of masonry. When works are well done at first the owner ever finds a pleasure and satisfaction in viewing them; and even the labourers feel much more interest in their good management, which is a circumstance not to be overlooked.

In the undertaking of business of this kind, it is necessary, before entering upon its execution, to fully consider whether the stream of water to be made use of will admit of a temporary weir or dam to be formed across it, so as to keep the water up to a proper level for covering the land without flooding or injuring other adjoining grounds; or if the water be in its natural state sufficiently high without a weir or dam, or to be made so by taking it from the stream higher up, more towards its source, and by the conductor keeping it up nearly to its level until it comes upon the meadow or other ground. And still further, whether the water can be drawn off from the meadow or ground in as

rapid a manner as it is brought on. Having, in addition to all these, too, an attention to all such other difficulties and obstructions as may present themselves, from the lands being in lease through which it may be necessary to cut or form the mains or grand carriers, from the water being necessary for turning mills, from the rivers or brooks not being wholly at the command of the floater, and from small necks of land intervening, so as to prevent the work from being performed to the greatest advantage, the operator may be in a situation to commence his works.

The water being thus under full command and regulation in every part of the land to be watered, by a proper direction, use, and form of the works, it is supposed necessary, in order to have an equal distribution, and prevent the waste of it, that no part of the meadow or land, either in the bed or catch-work mode, should be so formed as to be floated or watered directly from the main-feeder; but that all the main-feeders should be kept high enough to discharge the water into the small feeders with considerable velocity, and through a narrow opening. The motion of water is said to be truly mechanical; and that it requires a great deal of ingenuity, and a perfect knowledge of lines and levels, to make it pass over the ground in a proper manner. Each meadow or portion of land requires a different design, unless the land-owner or tenant makes up his mind to the heavy expence of paring off banks, and filling up such hollows as may be necessary to reduce it to some regular method, the construction to be varied according to the nature of the ground. This constitutes the difference between the watered meadows or lands of Berkshire and those of Devonshire. Those of the latter county being upon small streams carried round the sides of the hills, and are chiefly in catch-work; those of the former are near large rivers and boggy ground, being thrown up into ridges to create a brisk motion in the water; and also for the essential purpose of drawing off the superficial moisture which might be injurious to the grasses when shut up for feeding or mowing. Where there is much floating to be done with a little water, or rather where the great fall of a small stream will admit of its being carried over a great quantity of ground, and used several times, it is desirable to employ it in such a way, though meadows or land so watered are not to be considered as perfect models. If it should answer the purpose of a coat of manure upon such an extent of ground, it is all that can be expected, and will amply repay the expence. In all cases, losing fall is wasting water. All the drains of watered meadows or lands require no greater declivity than is necessary to carry the water from the surface; therefore, the water should be collected and used again at every three feet of the fall, if it be not catch-work. It is sometimes difficult to do this in bed-work lands; but where the upper part of the land is catch-work, or in level beds, and the lower part not too much elevated, it may be done. By collecting and using the water again in the same piece of ground before it falls into the brook or other course, a set of hatches is saved, and it is not necessary to be very particular about getting the upper part into high ridges, since that part of land which is near the hatches generally becomes the best, and the lower end of the field being often the wettest or most boggy in its natural state, requires to be thrown up the highest. If the land be of a dry absorbent nature before floating or watering, it is not necessary that it should be thrown up into high beds. There are many good meadow lands in the county of Wilts that have little work in them, and some that have neither feeder nor drain: but these are extraordinary situations that do not occur in almost any

other county, or they must, it is thought, have suggested the ideas already stated as to the origin of floating or watering. There is some reason, it is thought, from the natural warmth of peat-ground, which keeps it from freezing, that such land will produce an earlier crop of spring-feed than any other. At all events, it will first shew the advantages of watering, and gravel or sand may the next to it.

It has been suggested that if grass-land of the heavier kind could be ploughed in such a manner as to set the two furrow-slides or fods in a leaning position against each other with the grass sides outwards, the roots of the grasses would be perfectly dry all winter; the shoots would have the full benefit of the sun, and great advantage from mutual shelter. Upon wet land, this ploughing should be done the way the water runs. If the ground ploughed in this form before winter could be watered toward the spring, so as to give it a good soaking, it might be pressed down again to a level surface with a heavy roller. If these narrow ridges, too, were crossed with level trenches at every forty, fifty, or one hundred yards distance, according to the fall of the ground; and these trenches made to communicate with other main trenches, which should run up and down the slope, and supply or discharge the contents of those which are horizontal, such ground might be laid dry or wet at pleasure. And it is believed, that land so shaped might be floated or watered all winter with stagnant water to its great benefit, and probably in the spring too, if the water be changed at frequent and proper periods; for the water would remain only in the furrows, where there would be little or no vegetation, and the newly loosened soil of the ridges could not fail to absorb moisture, such as would promote the growth of the grass without any danger of putrefaction. The levels must be taken before a piece of ground be ploughed in this shape, and the earth taken out in cutting the cross-drains, be used in stopping the furrows on the lower side of them. Perhaps upon wet lands it would be necessary to re-plough them every autumn, or the strong lands might become too solid to receive the same benefit from the practice; and it will be necessary to level the ridges every spring, if the ground be mowed, but if summer-fed, it may as well remain in this form as any other. This easy method of getting land up into ridges, which are very narrow, gives to the surface all that inclination which is necessary for drawing off water, and is certainly so far likely to answer the purpose of watering. The water is thus under the same command as in any of the best-formed meadows or lands, and a much less quantity will be sufficient than under any other plan of watering. It is supposed that it might, probably, answer the purpose to float young wheat, or any other sort of grain, in some cases, by a similar method. It is thought that flat peaty ground, such as the level fens in Norfolk, which are subject to be covered a few inches deep every winter with stagnant water, would be much benefited by ploughing in this way before the floods commence. Some parts of it would thereby be raised above the water, and vegetate quicker in the spring, and the sedge matter growing up in the furrows, would in a few years raise them to the same level. The cross-drains, where on a declivity, would serve to catch and re-distribute the water, and the fall from one to the other must be very little. If this method be found not to do for watering, it is thought that four furrow-ridges of turf, with a small feeder upon each, would answer all the purposes of a more expensive system. There is always good grass by the side of the feeder, whether the water rushes over it or not, and a meadow or land of this nature would be nothing but feeders. It requires so little elevation of ridge and fall in

the feeders, that the water might soon be used again; therefore a very small quantity would suffice; and if there was a scarcity in the winter, the whole discharge might be stopped, and gradually lowered in the spring. This method would answer all the purposes of complete saturation, which seems to be one of the most essential parts of watering, and might be applied more or less, according to the time of the year. When the water is put on, it is supposed no grasses would sustain any injury by exclusion from the air for a day or two at the first application. If these ridges could be elevated but four or six inches above the furrows, it would give the surface nearly the same slope as the wider ridges of common meadows or lands; perhaps it would be better to begin ploughing the furrows wide at the ridge, and very narrow at the furrow, which would leave but narrow spaces for drains. If a piece of turf-ground were ploughed in such ridges by the common way of turning over the furrow, if it were set pretty much on edge, it is thought the grass between would soon cover the whole surface.

Ridges, too, might perhaps be made by beginning the two first furrows more apart than the usual width, thus leaving the width of one furrow between the two first to constitute the channel of the feeder. These ridges should be ploughed up and down, with only three or four inches fall between the cross feeders; and the water may be brought into use again at every other set of beds. If the ground require to be loosened every year, or every other, or two years or more, it will not be attended with much expense, and there will be no very great inconvenience in mowing ground in this shape, if the sides of the ridges be about a swath wide. It is thought that meadows or lands of this sort might be made for twenty-five or thirty shillings the acre, floated or watered with less water than catch-work, and have many advantages over it; namely, the water would lie more above the surface, would be more at command, and therefore changed more readily, and it may be pent up better to get a good soaking when scarce. This may be done more effectually in turns, and will run drier when the water may be taken off. It does not require much skill in the making or management. All the water will be let through nicks instead of running over a nice level edge, which in the first place is seldom made well, and in the next is difficult to keep in repair. This sort of work would, it is thought, have all the advantages of drains and feeders, whereas the same channels are obliged to serve for both in the common catch-work; it would require but very few or no stops, and consequently want but little attendance. It might be practised where there are six or eight inches of fall between the cross-feeder and cross-catch, as the water of each ridge, which should be short, may be led out by a fod with less trouble in the regulation than catch-work. See WEIR.

The whole of the channels and drains for carrying the water on or off the land, in the constant course and regular quantity which practice proves to be necessary, have two very distinct uses. The first sort or feeders bring a continued supply of water to make the slopes wet; and the latter by carrying it away, prevent the land from getting too wet in the time of floating or watering, and serve to render it dry when that operation is over, and to remove any superfluous moisture which may leak from the soil or fall from the clouds. The large ones which convey the water to the land, and along the main ridge to supply the others, are sometimes said to be the *main feeders*; and the branches that run along each ridge and distribute the water down the sides, the *floating feeders*. The first operation of floating or watering begins, or ought to begin, at the edges of these feeders; the main feeders being nothing more but channels or courses
along

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along which the water must pass, from the places where it can be found to the places where it is to have its effect. The place of its use lies between the floating feeder and the foot of the slope or drains, which are made in every furrow, for the purpose of catching the water; and which are said to be catch drains, and the large ones, which collect the water from these, main drains.

It is supposed that all floating or watering, in large rivers, may be done without constructing hatches, which are often attended with heavy expences and many inconveniences. If the proprietor has the land far enough up the river, nothing more is necessary, than to go thither and cut a channel out of it, which shall be deeper than the bottom of the stream. The water, which will be taken out in this new channel, may be dammed up by the hatches in it, at any place most convenient for getting it out upon the surface. To turn it into its old course down the river, nothing more is necessary than a hatch at the upper end of the feeder. Feeders constructed in this way will be extremely serviceable in time of floods, for by drawing both the hatches an entire new channel will be opened, which is generally much freighter than the old one. To contrive the shortest possible way to get the water upon the ground, it is evident that an obtuse angle is the best calculated for that purpose; it shortens the length of the feeders, facilitates the motion of the water, increases the velocity, and consequently preserves that natural warmth or motion which keeps it from freezing in the winter or stagnating in the summer. It also prevents the accumulation of scum, or whatever floats upon the surface, and enables the floater to distribute the water much more equally on every part of the work than if it went in a more circuitous course. The wind has less power to retard the motion of the surface, and the sediment which should go out upon the beds is less liable to lodge in the bottom of the feeders, and consequently the feeders will be cleared out with much less trouble and expence, especially if there be proper plugs or small hatches to draw up for the purpose of sending a stream through them. It may appear to some that these hatches are too expensive, or unnecessary, but practice proves that it is best to have them well done at first, which is doing them for a length of time. Inclined planes, too, are absolutely necessary for the purpose of watering. To form these between straight and parallel lines, it is requisite to dig away land where it is too high, and move it to these places where it is too low, to make such an uniformity of surface. The new-made ground will, of course, settle in hollows proportioned to the depth of the loose matter which has been lately put together, but such settlement will not take place until the new ground has been completely soaked with wet and dried again; consequently, these defects cannot be removed before the second or third year of watering; it will therefore require more skill to manage watered land for a few of the first years, than may be the case at any time afterwards.

In conclusion it is noticed, that however simple the construction of a watered meadow or land may appear upon a superficial view, those who enter particularly into the concern will find it much more difficult than is commonly supposed. It is no easy task to give an irregular surface that regular yet various form which may be fit for the overflowing of the water. It is quite necessary for the designer to have just notions of lines, levels, and angles; the knowledge of superficial forms will not be sufficient. Accurate ideas of solid geometry, somehow acquired, are absolutely necessary to put such a surface into the proper form for the reception of water, without the trouble and expence of doing much of the work twice over.

Division of Watering.—The practice of watering land may be divided or distinguished into two principal heads or modes; as those of performing it in flat work or flat-flooding, and in sloping or catch work. Each of these divisions has, however, many varieties in the methods of executing the business, as will be seen below.

In the former, or that of watering lands in flat-flooding, there must be a full supply of water, which serves only one turn, and is then carried off the field. There should be a very moderate but uniform declivity in the surface of the land, and the requisite expence be incurred by the undertaker. But though in such works a very small gradual declination will mostly be sufficient, there will be considerable variety in this particular, according to the actual form of the land. The most desirable and perfect declivity for this purpose has been found to be in the ridges, from the upper to the lower extremities of the field, one inch in every nine yards. With this gentle fall, the water passes over by the mere contraction of the feeder, without any stop; but such exact declivities are seldom had. It is also found that the declivity of the sides of the ridges, from the crown to the furrow, should be about two inches for every yard; so that, supposing the ridge to be ten yards broad throughout, and every side to be in the form of an inclined plain, declining in this proportion, the crown may be ten inches raised above the furrow, measuring by the surface at each part. In these proportions, however, there is great actual variety. It is by no means uncommon to find the ridges fourteen yards wide; and when the water is very scanty, they are sometimes twenty yards in width. Where there is a full stream of water, the narrow ridges are found to produce the greatest crops in proportion; but the expence of forming them is likewise greater. Where the field or land has an uniform surface, and the declivity suits, one principal feeder may serve the whole. It is to be cut so as to be the widest at the upper end, contracting all the way as it descends. Notches are to be cut in the bank on the side next the land; and a notch opposite to and communicating with each of the lesser feeders, in order to supply them all in succession with water. These smaller feeders, too, are to be formed so as to be the largest at the heads, contracting gradually as they descend, until near the lower end of the ridge, when the small feeder entirely disappears. The corresponding small drains are made somewhat less than the feeders, though not much less, and the proportions of the drains are reversed, being formed the largest at the lower ends, and diminishing into scarcely any thing at the upper ends.

But though the surface of the field or land should be uniform, yet if the descent in the line of the principal feeder be too rapid to admit of its giving supply to the lesser feeders, in a regular manner, without great stops or hatches, the method below may in that case be had recourse to. The main ditch may act as a conductor only, not as a feeder; and parallel to it the main feeder may be formed in several different parts, each of which is easily levelled up, so as to supply five or six ridges, and is itself supplied from the conductor, by simply adjusting a stop or hatch for every subdivided feeder. If the surface should consist of separate and gently rising swells, there must be a main feeder branching away from the conductor to supply every ascent, on the top of which this feeder is formed; while a corresponding drain is cut at the bottom, and the respective ridges are marked out and formed between the feeder and the drain.

If it should be necessary, some catch-work may be intermixed, so as to water the irregular portions of surface, which possess a degree of declivity answering to that mode

of watering; and too much of it to be conveniently and properly watered in flat flooding.

The ridges being formed, and all the feeders and drains cut out, and their materials placed and disposed in such a way as to render the surface as regular and correct as can at first be done; the seeds of proper grasses should in some cases be sown, but in others it will be unnecessary. When the land is ready in the spring, the seeds may be sown with a thin crop of some early grain kind, but it may be as well to sow the seeds alone towards the beginning of the autumn if the land be then ready.

In the latter mode of watering, or that of catch-work, the principle consists in floating as much of the surface, as can be done, in the way most suited to the form of the grounds; taking care to prevent the water from sinking or stagnating; and collecting it again to be a second time, or more frequently thrown over new surfaces of the land. In order to put it in the power of the floater to receive the water, and to throw it again over some other portions of the ground, there must be a declivity sufficient for such purposes. A smaller quantity of water may be enough for watering, according to this method, than is necessary in flat flooding; and as the water is accommodated to the form of the ground, and no ridges required, the expence of watering in this way is generally very moderate, in comparison with that of watering flat meadows or lands. It is well adapted, too, to those gentle declivities which produce very little in the state of nature, but may become highly valuable at little expence, when properly watered. On these and some other accounts, it would seem that all the preference to flat meadows or lands, that has been commonly claimed for them, is not due. At least, it admits of no question, that watering in catch-work, when properly executed, is a very beneficial and advantageous method.

The principal objection to this mode of watering is, perhaps, in the seeming unequal distribution of whatever nutriment the water may contain, which has certainly some weight in it; as the first surface over which the water passes, must of necessity have the advantage. It should not, however, be entirely forgot, that in most cases of land in such declivities the considerate farmer bestows most manure where the soil or land is the most thin and poor; and the water of catch-work meadows or lands does the same; the higher situated grounds receiving it and its benefits the first, and afterwards those which are lower, and, for the most part, richer, and deeper in point of earthy staple.

In this mode of watering, the feeders and drains are cut in a direction passing across the slope of the surface of the land; and having no greater fall, as the water flows in them, than to cause it to move gently and freely, without either stagnating, or acquiring such a rapidity, as might endanger the works. In order to accomplish the work in this easy way, the water may be introduced at an upper corner, where it passes gently, and by a very small declivity in the feeder across the slope, and overflows the surface below its tract. A drain, at a proper distance below, receives the water, and transmits it into another feeder, cut on the same plan as the former, where it again overflows, and is again taken up in a drain to be sent over new surfaces.

In this manner, a moderate quantity of water may float a set of different spots lying in a diagonal direction, until it arrive at length at the bottom of the watered grounds, and reach a drain which carries it off completely. An entirely new set of different spots may then be watered in the same manner, the drains in the first process, or case, acting as feeders in the second, and the contrary in other cases. But catch-work watering, so far as regards the method of per-

forming it, admits of almost an endless variety. A conductor with stops may be formed, pointing directly down a declivity, if the rapidity of the current be not suspected as dangerous for forcing up the channel in which it flows. From this conductor, feeders may be formed at right angles, to the right and to the left, or in either direction; and the stops in the conductor send the water into these feeders; which, being formed only a very little off the level, soon fill and overflow the grounds below them. The surplus water is collected in drains parallel to these feeders, which restore it to the conductor, whence it can again be diffused to right and left, in order to float a lower situated surface, from feeders constructed in the manner already seen.

There are many other ways of watering in different cases of this nature; but where the lands are necessary to be laid down into permanent meadows, the works should evidently be substantially executed at once, and with proper care and design, whether the method be catch-work or flat meadows or grounds.

Regular plans of this mode of watering may be seen in the last editions of Wright's tract on the "Art of floating Land," and of Young's "Farmer's Calendar."

The writer of the work on "Landed Property" has given practical directions for four different methods of applying it artificially on the surfaces of grass lands, which may be useful in guiding the practice of the inexperienced.

1st. Flooding or covering low flat Lands with stagnant or slowly-moving Water.—This is a mode which, it is thought, was formerly, perhaps, the only one in use, in this country, for enriching the bases of valleys by the means of water. In the midland districts, tradition, it is said, speaks of it with familiarity. And the remains of works that have been used in practising it, are still evident. Even in the western districts of the southern range of chalk hills, which have long profited more by watering, than all the other districts of the island, this, it is more than probable, has been heretofore the only method in use. It is indeed an interesting fact, it is said, that the far-famed long-grass mead of Orcheston, in the county of Wilts, is still watered in this manner. But it is conceived that there are now, however, few situations in which this method can be practised with the best effect. The one for which it is the most applicable is, it is supposed, a *drained morass*, or other flat moory ground, through which a stream naturally passes, or to which a sufficient supply of enriched waters can be led. A body of water, resting on a light spongy surface, tends to compress and consolidate it; while the sediment of foul waters, let fall in passing from an agitated to a stagnant state, further promotes this tendency. The rich moory meadows and pasture grounds, which are seen in various parts of the kingdom, were doubtless, it is thought, brought to their present profitable state, by being flooded with stagnant or slowly moving waters.

Another, and perhaps the only other, sort or class of lands, to which this method can now be properly applied, is *dry valley grounds*, which are composed of a sufficient depth of soil for the pasture of herbage, with a subsoil of flints, pebbles, or rough gravel, to draw off quickly the superabundant moisture that may be left in the soil, after its surface has been freed from water; and, thereby, to give vegetation the immediate freedom of action. But lands of this sort, having a sufficient command of water to flood them, are much less common, in this country, than those of the former class or kind. The valley of Orcheston is, however, in itself, it is thought, a sufficient stimulant for searching narrowly for lands of so valuable a formation, and which can command fertilizing water to flood them; as they may generally

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nerally be watered at less expence by this, than by any other method.

The method of flooding flat or dishing lands artificially with standing water, is simply, it is said, that of raising a dam across the lower end of the site of improvement, of a sufficient height to overflow the land, and proper strength to sustain the weight of the water; with a channel at each end, to carry away the overflow; and with a valve in the middle or lowest part to draw at pleasure.

Where the subsoil is not sufficiently absorbent and open to free the upper soil of superfluous moisture, presently after the body of water has been drawn off, a main drain should be run up into the area of the site, and lateral ones be branched off from that, to wherever the water is found to hang; whether on the surface or in the subsoil. But where the subsoil throughout is retentive, though but in a small degree, the land may be considered as improper for this mode of watering, as will be seen below.

2d. Watering flat Lands with running Water, when raised into Ridges.—This is a method of practice which is conceived to be modern when compared with that of flooding, drowning, or covering the entire surface with standing water, as being a spirited mode which is still, as a general practice, confined to one part of the kingdom. Among the chalk-hills of Wiltshire and Dorsetshire, but especially the former, there are large tracts of water-formed valley lands, which have long been watered with scientific accuracy and correctness. These lands, it is probable, were first brought to a firm state of sward, by flooding them, during a great length of time, with standing water; and have been since moulded into their present form; been raised into ridges, or other inequalities, in suitable manners, and properly watered.

It is proper and necessary, however, before so expensive a practice be recommended, to explain the principles on which it proceeds, and on which it may be profitably pursued and had recourse to; where suitable ground, and a sufficient supply of water, which is proper, can be employed. It is noticed that plants, as well as animals, have their natural elementary matters. That water plants, aquatics which root beneath the water, live but in this fluid, where they are secluded, in a certain degree, from air and heat. On the contrary, the agricultural vegetables of this country, among which are to be reckoned the more nutritious meadow plants, require a free communication of atmospheric air and heat, to every part of them: they cannot live with their roots immersed in water, nor flourish while water is lodged immediately beneath them. And between these two opposite tribes of plants, is found an intermediate one, which is somewhat amphibious, or partakes something of the nature of both,—the plants of which delight in water, yet can live, though not flourish, on dry land,—provided it be of a cool nature or quality.

It is stated that where the soil of low flat meadow lands of this nature, rests on a retentive base, the palustrian sort of plants seldom fail to intermix with the meadow herbage. In a season which is favourable to dry land plants, the superaquatics are kept in a dwarfish underling state. On the contrary, in a wet season they flourish; while the better herbage becomes weak and unproductive. If, through neglect, the soil or land be suffered to remain saturated for some length of time with water, the meadow plants dwindle, or die, and the ranker wet-land weeds take possession. Hence, in the practice of watering, the propriety of quickly relieving the soil or land from superfluous moisture or wetness, in order that the better herbage may gain the ascendancy; especially in the spring, when a few days of warm weather at the critical juncture may give the one or the other a su-

periority during the early summer months. Even in meadows where the superaquatics do not abound, the same principle of practice holds good; for it is well known to common observation, that flat retentive meadows, which do not readily shoot off surface-waters, are materially injured by a cold wet spring: by which the finer more nutritious herbage is cut off, or wholly checked; so that the hay-crop proves thin, is of small bulk, and of an inferior quality. But further, though it be evident that water, even standing water, may remain for a short time upon dry land-plants with impunity, especially in a cold season; yet wherever it is suffered to lie long on the surface, particularly during warm weather, there, dry land-plants, in general, are destroyed, are probably suffocated for want of that supply of air which *standing* water is incapable of affording them. Hence, it is supposed, appears to arise an advantage of watering with *running* water; and hence, too, the propriety of watering by *intervals*; in order to enable the plants to recover their strength, and to exert their natural powers of imbibing the nourishment the water may have provided for them, and thereby increasing their strength. Besides, the warmth which moving bodies, even agitated liquids, naturally generate, may be suggested as another advantage of watering with running water.

These considerations may, it is supposed, sufficiently explain the reason for laying up cool flat lands into ridges for the purpose of watering. Experience has well ascertained, it is said, that where calcareous water, at least, is spread over a sufficiently sloping surface of grass-land, the superaquatic plants disappear, while the more nutritious grasses luxuriate. On the contrary, where the same sort of water is suffered to loiter on a flat soil, lying upon a retentive base, the grosser wet-land plants prevail. And further, that the same or similar water in its nature, thrown over the same or a similar sort of soil, with the same turn of surface, but with a dry absorbent base, produces luxuriant crops of valuable herbage. And, from long continued observations on facts of this nature, has doubtlessly arisen, it is thought, the present *practice* of Wiltshire and its neighbourhood.

The work of raising flat lands into water-mead ridges in these cases, is directed to be performed in this manner. In a suitable situation, where the stream of water can be properly received to begin and mark out a plot of the green sward, or land, of the proper length and breadth for the purpose. Then if to be done by the spade, to roll back the turf after it has been cut, and form the earth of the soil into the proper shaped convex ridge, being careful in forming it, to keep the best of the mould constantly toward the surface, and leaving the opening on the ridge eight or nine inches or more deep, and nearly level; the end towards the stream being made somewhat higher and rather wider than the other, that the water may flow evenly over every part of the ridge. The turf is then to be returned, being careful to replace it evenly and firmly along the sides of the trench in the middle; and cut a drain on each side of the ridge thus formed, with proper outlets to carry away the waste water. Lastly, raise a channel between the ground and the source of the water, to conduct it into the watering-trench; and continue to adjust the ground until the well flow evenly over every part of it. The most proper forms, and the degrees of convexity which are the most suitable in different cases, will be seen below.

This work may be performed either with the spade or with the plough. The former is the more expensive method, but it is the more accurate, and sooner brings the improvement to profit. By the spade, the natural earth and soil are again distributed on the surface. By the plough much of them is

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buried under the ridges, while the furrows are left destitute. Where there is a great depth of fertile soil, the plough may be used with better effect than where the soil is shallow.

The next consideration is the elevation and convexity of these meadow ridges. On the principle offered, it is said, the steeper the sides are formed, the more beneficial will be the effect of the work. But it is not less certain that the expence of it will be proportionally great. Something may depend on the nature of the materials of which the ridges are to be formed, and the method of forming them. If, in moving the materials, a regular stratum of flints or gravel can be buried, at a proper depth, as an open subsoil, a small degree of elevation will be sufficient. In ordinary cases, one foot of rise to sixteen feet and a half, or a statute-pole of base, will suffice; provided the drains between the beds be sunk to a sufficient depth. One foot of rise to five feet and a half of slope, or eleven of base, may be considered as the maximum of elevation in these cases. On these premises, it is concluded, that a ridge set out one statute-perch in width at the base, requires an elevation of from nine to eighteen inches at the ridge; one of two perches in width, an elevation of from eighteen inches to three feet, according to the nature of the materials by which it is formed. In respect to the *turn* of surface, or form of the slope, there are sufficient reasons why it should be convex, not a regular inclined plane, nor of a concave or hollow cast. A regular sheet of water spread over a sloping surface has a natural tendency to break into streamlets, and to collect into partial currents. In the process of watering, this effect is produced in part, by the unevenness of the surface it is spread over, and the obstructions it meets with in its descent, as well as by the natural propensity of falling waters to collect into a body; and the steeper the descent, the greater freedom of action this propensity acquires. Hence, the propriety of giving the water a gentle descent on the upper part of the slope, in order to preserve the entirety of the sheet as far down the side of it as may be; and this is effected by the convex form, which also gives firmness to the sides of the trench. Besides, a convex surface, while it lessens the descent at the ridge, increases it at the foot of the slope, and thereby hastens the drying in that part; to which the superfluous moisture of the entire slope tends, and where noxious plants are most liable to gain a footing; the earth or soil being there kept the longest in a state of saturation.

The width of these convex beds is a matter of much consideration. In what has been said of their elevation, it plainly appears that the expence of forming them is in proportion to their width. An acre of ground may be raised into beds of a rod wide, with the mentioned slope, at half the expence that another acre can be formed into those of two rods in width, and the same slope: the latter requiring to be raised at the ridge twice the height of the former; besides the work in this case being within a smaller compass. And from what has been said of the form of the slope, it is equally clear, that water may be more evenly spread over a narrow than over a wide or deep slope; and that a narrow bed will dry more quickly than a wide one of the same soil and substrata. Nevertheless, there is an advantage of wide ridges, which, in some situations, may more than over-balance all their inconveniences. A given quantity of water will float twice the quantity of ground, though perhaps not with twice the profit, when raised into beds of two poles wide, that it will in those of one perch in width, besides the current expences of management being less. If, however, the quantity of water be great in proportion to the extent of ground, or if it can be collected again, and spread over other lands belonging to the same owner, which lie below those

that have been watered, narrow ridges may claim a superiority. Hence, the proper width of watered meadow ridges depends much on soil and situation, and on the quantity of water proportionate to the quantity of ground. In the neighbourhood of Salisbury, the prevailing width, it is said, is ten yards, nearly two perches. In the vicinity of Amesbury, there are some of three times that breadth or width, but they are nearly flat. From one to three poles may fairly, it is thought, be set down as the ordinary limits of width.

In respect to the arrangement of these meadow beds, and the general economy of watered meadows or lands of this nature, almost every thing may be said to depend on the particular circumstances of the given site. But supposing a copious stream of good water to pass through a flat of water formed land, in a dilatation of the base of a valley; and supposing the situation of it to be nearly level from side to side of the same, or to have a gentle descent, the banks of the stream towards the outer margins; a case which often occurs where flat lands have long been liable to the overflow of foul waters. In this case, the beds require, it is said, to be run across the valley in a direct or oblique manner, as the descent may point out; and the water to be conducted to them by an artificial channel, winding on each side of the natural stream, with a main-drain near each outer margin, leaving room for a carriage-way between it and the foot of the bank of the valley; and where the grounds to be watered are wide, other road-ways may be left between the conducting trenches and the bed of the brook or rivulet. These dry slips of land are useful, not only in conveying away the crop, but in furnishing comfortable lodging-grounds for pasturing stock when the area of the land is moist. It follows, of course, that these road-slips should be watered with caution, late in the spring and during the summer months. The most eligible method of raising the water high enough to fill the trenches, is that of placing folding-gates, like those in use for navigable canals, across the stream, at the upper end of the ground to be improved. In summer, or when the water is not wanted for use, the gates may be thrown open, and fastened back, to give free passage to floods. But during the time of watering they are kept shut, to throw a constant supply of water into the main trenches. If the descent downward of the valley be considerable, the main trenches or conducting channels require to have stops, or rather checks, placed across them, at distances proportioned to the descent, in order to fill with due effect the working trenches, the mouths of which open into the conducting channels; and, to gain more perfect command of the water, the mouth of each acting trench should be furnished with a regular valve, to admit just water enough to supply the given ridge while under watering, and to close the entrance effectually when it is laid. A lifting-board in the form of a shovel, with a short handle, and sliding in upright grooves made in the faces of two slender posts, joined together within the ground, becomes a simple and desirable regulator for the purpose. And where a meadow ridge happens to be long and much declining, a circumstance which should, as much as possible, be avoided: checks are likewise requisite to be placed in the working-trenches, to assist in distributing the water evenly over its surface. These checks are formed in different ways. Two thick tough sods placed in the trench, so as to leave an opening between them narrow enough to force a sufficient quantity of water over the sides of the trench above them, and wide enough to let the remainder pass down freely into the lower part of the trench, form a ready and not ineligible check for this purpose; as the opening may be easily widened or narrowed

rowed at pleasure. If the descent straight across the valley be not sufficient, where the descent down it is considerable, it is advised to direct the beds obliquely across it, and by this easy mean gain the required fall. But where the base of the valley is wide, so that the length of the beds, if run out from the natural stream to the outer bank, will be too great, as from fifty to a hundred yards, wind a conducting trench along the foot of the bank, as well as by the side of the brook or rivulet, and sink a deep drain in the midway between them. As to what regards the dimensions of working trenches, they should vary according to the breadths and lengths of the beds to be watered. The wider and deeper they are formed, the more freely a large body of water will pass along them. Hence it is evident, that the upper end of a long trench should have the larger dimensions, in order that a sufficient supply of water may pass freely to the further end, where the dimensions are required to be less; as the uniform contraction serves as a continual check to the water, and thus tends to force it in its passage over the sides of the trench. From six to fifteen inches wide, and from four to ten inches deep, may serve to give a general idea, it is said, of their dimensions.

3d. *Watering by Spreading running Water over naturally uneven Surfaces.*—In the more western counties of this country, but particularly in Devonshire, this practice has been established time immemorial. Even tradition there speaks not of its origin. The spring-waters that issue from the slate-rocks, which are there the prevalent substructure, are of a fertilizing nature; and the steep valleys that there abound are mostly covered with a rich deep soil, fit for hay-ground. Such circumstances may well serve, it is said, to account for the prevalence and antiquity of the practice in that part of the kingdom. Something of this practice, on a small scale, too, has been long in use in different parts of the country for spreading the overflowings of dung-yards and pits, and the wash of home-stalls over grass-lands lying below them. Of late years, also, it has been employed in different districts, in distributing the waters of more copious streams; and numerous instances still remain in which the practice may be extended with great and valuable effects.

If the quantity of water be small, whether it flow from a farm-stead, or a spring of superior quality, it should, it is said, be collected in a proper place, whenever it is not employed on the ground; more especially in the spring months, while the hay-crop is growing, in order to be able to liberate it, should its growth be arrested by a dry season, and to meliorate the soil as soon as the crop is off the ground for the benefit of the after-growth. The ground or situation of improvement is mostly given in the source of the water, or the point at which it can be commanded. Where this is a matter of choice, it is generally advisable to run the channel of supply along the brink or brow of a slope, as above: thus giving the flatter lands above it to the plough, to which in upland situations they are best suited, and the steeper to the scythe, as watered hay-grounds, for which they are the most eligible; extending the ground downward to the foot of the slope, and to the flatter lands beneath it, provided their subsoil be absorbent and open, and the given quantity of water be sufficient for the whole extent. The canal or artificial water-course from the natural stream or other source of the water, to the ground of improvement, requires a certain fall, to give a due degree of current to the water it may convey. If the motion of water in a supplying channel be sluggish, part of it is liable to sink, and be lost by the way. Slowly moving water does not tend to make the bottom of the channel firm and water-tight, like a

living stream: nor will a channel of the same size convey an equal quantity of water in the same time; nor will it clear itself so well from obstructions, as with a quicker current. On the contrary, dead water gives the suspended matter, which should be conveyed as nourishment to the plants, an opportunity of being deposited by the way in the form of mud, for want of agitation, and thereby fouling the channel. On the other hand, if the current be made too rapid, it is liable to wear the channel, and to cause unnecessary repairs. Besides, where all the height that can be properly got is required, every foot of superfluous fall contracts, unnecessarily, the field of improvement. On the grounds of practical experience, it is supposed, that one *per cent.* as one inch, foot, or yard of fall, in every hundred inches, feet, or yards of distance, is, in ordinary cases, the proper fall: this giving an active but inoffensive current. Under the above circumstances, and where the length of channel required is great, one-half *per cent.* may be made to suffice. Two-thirds of the ordinary fall gives a degree of life to the stream, and may, in many cases, be eligible and proper.

In setting out water-courses of this nature and sort, the use of the level is necessary; and the best forms of such courses, whatever the size may be, are those of inverted arches, as clearing themselves better when low in water, and giving firmer banks on the lower sides than is the case with square flat-bottomed steep-sided trenches. The modes of performing the work, and of laying them out properly, must be directed by the particular turn of the surface of the grounds.

In the low lands which lie at the feet of the sloping grounds, the natural surfaces of which are sufficiently uneven to admit of running water being spread over them, without the assistance of art; and the substrata of which are sufficiently absorbent and open, to permit them to dry quickly, after the water is taken off: the method of watering, where they lie pretty regularly shelving, is to lead the water along the higher side of the land, and to draw it off by a main-drain on the lower side; straight working trenches and corresponding drains being cut, downward of the area, so as to spread the water over the whole, without suffering it to lodge on any part of the surface. This is that which may be distinguished by the Devonshire practice, or manner of watering.

Where, however, the surface is more irregular, lying in natural swells and ridges, with dips and hollows between them, the water is to be led along the tops of such higher parts, without regard to the straightness or regularity of the trenches; and the drains to wind up the hollows and lowest ground with the same irregularity. There are two ways of ascertaining the true lines of the trenches and drains in cases of this nature. The one is by flooding the entire area, where it can be done, and driving down levelling-pegs over every part of it, so as to leave their heads uniformly level with the surface of the water; which being let off, the shortest pegs shew the proper lines for the trenches, the longest those of the drains. This method was used by Bakewell, in Leicestershire. The other, which has occurred in the writer's experience, is attended, it is said, with less trouble and inconvenience. The higher parts are readily ascertained, and the lines of the trenches accurately traced by a proper levelling implement; artificial mounds being raised between the detached knolls when wanted. After the fresh-made ground has properly settled, and the trenches have been duly formed, the water is turned on; and by this ready mean, the proper lines of the drains are accurately given. This is an easy way of watering valley lands; and

where the irregularities of surface are sufficiently great, and the subsoil absorbent, it is very eligible; especially, if in making the trenches and drains, the turf and soil so raised be applied in adjusting the natural defects of the surface.

In the watering of more steeply sloping grounds, as the sides of hills, and the lower banks of valleys, in what may be termed the Devonshire practice, as having been long there and thereabouts chiefly established; as there, the sides of the valleys lie in or nearly in their natural states; many of them appear as if they had never been subjected to the plough; and those which have been in tillage, have been laid down again to grafs with nearly their natural surfaces. The practice of laying up soils into high arable ridges, has never, perhaps, gained a footing in that part of the kingdom. In these cases, the conducting channel being led along the brink, and across the upper part of the slope, as advised, the working trenches are to be supplied from it by means of checks and valves, as already seen. The distances between the working trenches are to be regulated by the steepness and evenness of the surface. Wherever the sheet of water is seen to break, and to divide into numerous streamlets, there a trench is required to catch and respread it; the working trenches, in this manner of watering, acting in the two-fold capacity of trenches and drains: fresh supplies of water being let down from above, to the lower trenches, as occasion may require.

Where the depth or downward length of the slope is great, or where an additional supply of water offers itself, and where reservoirs are formed at different heights, an additional main-channel is required, to lead a fresh supply across the midway of the slope. This main-trench likewise receives the waste water from above; and, like the working-trenches, acts at once as a supplying-channel, and as a receptacle of the waste water: hence, a given quantity of water will float a much larger extent of ground in this manner of watering, than in watering ridges, raised on level ground; though, it may be presumed, not with equal benefit.

In forming the trenches of whichever sort, the turf and loose earth that are raised out of them, and which are not wanted to make their lower sides firm and level, are to be used in filling up the channels and dimples that naturally happen in the face of the slope; in order that the water may spread more evenly over it, and thereby to lessen the requisite number of trenches. To the same end, if hillocks or small protuberances occur, as they generally do on natural surfaces, they are to be lowered by turning back the turf, using their contents as above, and returning the sods to smoothed surfaces. But, where the knoll is large, water may be led by a narrow branching trench to its top, and be thus spread evenly over its sides. The proper descent or decline of the working trenches depends, in some measure, on the press of water that enters them. One quarter *per cent.* may serve as a guide in setting them out: first making them of inferior dimensions, and then turning on the water: afterwards enlarging them, and in doing this, adjusting them in such a manner, that the water will flow evenly out of them, from end to end. The shorter the acting trenches are made, the more easily they may be regulated without the incumbrance of checks, which should be avoided as much as possible.

4th. Watering sloping Grounds that have been raised into Ridges by Cultivation, and are in the State of Grafs.—In watering ridges on slopes, or such shelving grounds as have formerly been in a state of aration, in which they have been raised into high wide convex beds, resembling those advised above, for flat meadowy surfaces, and have been laid

down to grafs in that form; a practice which, it is supposed, has been common to many parts of the kingdom, especially where the common-field system prevailed; the direction of the ridges being mostly directly downward of the slope. In this case, it would be in vain to attempt to spread water over the surface, in the manner usually practised on more even slopes. And if it be thrown into open trenches, cut along the tops of the ridges, agreeably to the practice in use for level grounds, and according to the ordinary practice of watering the lands now under consideration, the operation becomes very imperfect. For, if the descent be considerable, the water will unavoidably flow out of the trenches in streams immediately above the checks; and the sides of the ridges will consequently be watered partially. These difficulties in spreading water evenly over ridges on steeply shelving surfaces, have led some industrious managers to throw down the ridges, and return the slopes to their natural states. But this, where the ridges are high and wide, is very troublesome and expensive if done by hand; and if performed by the plough, is greatly injurious and hurtful to the land for many years. A better method has therefore been had recourse to by the writer. Instead of leading the water down the ridges, it is thrown into the furrows, and spread over the sides of the beds by means of crooked trenches, winding, in the festoon manner, horizontally, or nearly so, across them, and led more effectually over their tops by pointed trenclets depending from the festooned parts. These winding trenches, like those across plain sloping surfaces, act both as feeding-trenches and as drains, or collecting trenches, to respread the water evenly over the ground, immediately below them: thus keeping the entire ridge covered with an even sheet of briskly moving water. When the upper ends of the ridges are sufficiently watered, the water is to be let down the furrows to the parts below; or if the ridges are short, their whole length may be watered at once, by letting the water partially down the furrows to the lower parts, by the means of cuts of proper widths, made with a sharp tool across the lower sides of the trenches, where they cross the furrows: these simple regulators acting as checks in the common modes of watering. The distances between the trenches, as well as their form, must always vary with the steepness of the slope or descent, and the shape of the ridge.

Considerable tracts of land in North Wales have been watered in somewhat this manner of late years.

In concluding, it may be stated on the best authority, that the beneficial practice of watering, by some of the methods which have been suggested above, may be greatly extended and applied in different parts of the country where it has yet been but little tried, as on the fenny lands of the counties of Lincoln, Norfolk, Cambridge, Northampton, and, perhaps, some others, where it is particularly desirable, as well as the bottoms of the chalk-hills in different districts, as Yorkshire and Suffex, and the vales of Hertfordshire, the chalky parts of Buckinghamshire, Oxfordshire, and Suffolk, which are peculiarly fitted for the purpose; besides many others where good waters are afforded for making such improvements on grafs-lands.

WATERING Live-Stock, in Agriculture, the business of giving and providing them with water. The work is effected in different ways, and by different means. See *DRINKING-PONDS, MADE STREAMS, WATER-CISTERNS, WATER, Rain, Collecting of, SPRING, Artificial, WELL, Field, &c.*

WATERING Plants and Fruit-Trees, in Hot-houses, Stoves, &c. in Gardening, the practice of throwing water over them in different intentions. The common modes of applying water have been spoken of in considering the general practice

of garden-watering, and under the heads of the different plants, as they may require it; but the nature of its application, in these cases, may be explained in the present place.

For plants in these situations, Mr. Fordyce has advised the use of simple water only, in clearing them from different nuisances to which they are exposed, though lime-water in other cases may be more powerful and have a better effect, as will be seen below. It is directed to be applied in this manner. About four o'clock in the afternoon a barrow-engine is to be filled with soft water, or such as has been exposed to the sun through the day, and wheeled along the foot-paths of the houses, where they are wide enough to receive it, and the whole of the plants sprinkled with the fluid, by pressing the finger on the top of the pipe of the engine, in order to spread the water somewhat in the manner of a fine shower of rain, playing the engine and throwing the fluid likewise against the top-lights and shelves of the houses, until the water stands an inch deep in the paths of the houses. A small copper engine may be made use of, and answers very well, when a barrow-engine cannot be got into the houses. It may be had in most places. But if an engine should not be conveniently at hand, which can be got into the houses, the front-lights may be opened, or, where there are no front-lights, the top-lights may be slid down, and the water be thrown in at the fronts or tops. When this operation is begun, if in the inside, every light must be close shut down; and if the water be thrown in at the fronts or tops, one light only is to be kept open, which is immediately to be shut, when that part of the house, which is opposite to it, is sufficiently watered; then proceeding to open others until the whole be properly watered. The houses after this are to be kept close until the next morning; which will cause such an exhalation from the glass of the houses, and the beds that may be in them, if there should be any, that the plants will, it is said, be covered all over with steam or vapour; which will infallibly destroy and clear them of the vermin and other hurtful matters that may be upon them, especially those of the plant-louse and coccus kinds. This sort of watering is, however, to be repeated every afternoon, in the time of hot weather only. By it a great deal of labour in watering will be saved; but such plants as stand in need of much watering, should have the water given them before the sprinkling of the houses is begun. In most cases, the plants will have imbibed all the moisture before morning, and the paths of the houses will be perfectly dry.

As it sometimes happens that in hard winters, when strong fires are under the necessity of being kept in the stoves or other houses night and day, that the plants which stand on shelves in those of the dry kind, are so parched up, that the leaves drop off, as from deciduous trees in the autumnal season, which renders them very disagreeable in their appearance; it should be prevented or remedied by watering, in the manner directed below by the same writer. About eight o'clock in the morning, when the sun shines out, and there is the appearance of a fine day, water is to be thrown into the houses until the floors are covered to the depth of nearly two inches; they being kept shut the whole day, unless the heat rises very high, which is seldom the case at such a season of the year, but when it does happen, the doors may be opened to admit a little air. By the middle of the day, the water becomes entirely exhaled, and the floors quite dry. The operation may be repeated two or three times in a week in sunny weather. The plants in the course of a week's time begin to recover, or throw out new foliage, and in a fortnight or three weeks become in full leaf again, displaying themselves in a fine manner;

This sort of watering is greatly useful on many other occasions, as in the growth of plants in the pits of such houses.

Fruit-trees in such houses may also be watered in the same manner with much benefit in some cases; but for those against walls, a lime-water prepared by putting thirty-two gallons of soft water to half a peck of unslaked lime is recommended to be used in this manner. With the clear liquid, after the lime has subsided, the engine is to be filled, and a good watering given to the trees, throwing a considerable part of it forcibly under the leaves, and spreading it finely by the means directed above; at the same time, wheeling it backwards and forwards, that no parts of the trees may be missed. This should be performed when the weather is cloudy, or when the sun is off the wall that contains the trees. Where the trees are on an east wall, the watering may be begun about half past eleven o'clock; if on a north wall, the watering may be done the first thing in the morning; and when they are on a south wall, it may be executed about four o'clock in the afternoon: it is to be repeated once a day for six or seven days in succession. If, however, there should be cold northerly or easterly winds, or frosty nights, such watering should be discontinued until the weather becomes more mild and temperate. Care is constantly necessary that the trees get dry before night, and that no watering takes place while the sun is upon them. Care is likewise to be taken not to water them with any of the grounds of the limey liquid, which would injure the leaves, and make the trees look very unsightly.

This sort of watering, with the use of lime and wood-ash dust to the under-sides of the leaves, are found extremely effectual in destroying and clearing away every thing noxious about the trees, and in rendering them healthy and productive. See WATERING, in *Gardening*.

WATERING-Pots, Pans, or Cans, are such contrivances of this nature as are suited for pouring water over seeds, plants, trees, &c. in pots or otherways in a fine showery divided state, they being provided with strainers or roses of a finer or coarser kind for the purpose, well adapted to their spouts. They are particularly convenient for potted plants of all sorts, as well as many other kinds. They form the principal mode of hand-watering.

WATERING Sheep, in *Agriculture*, the supplying them with water. This is particularly necessary in the management of flocks in some situations, as on the South Downs; and as there is there no other water than what is to be collected by some artificial method, ponds are constructed for retaining such water as falls in rain; those, for this use, are commonly made circular, and very gently sloping to the centre; the bed very strongly rammed down to prevent any loss by soaking through the chalk. As ponds are liable to become leaky, and to be spoiled by a hard frost, they are made by lining them with chalk, puddled and trod down until it makes a sort of plaister floor. If a little good stone lime were sifted evenly over the whole and trod well in with the chalk, it would probably effect the business of rendering them perfectly retentive of the water under all circumstances.

In Italy the sheep-flocks were regularly watered morning and evening, as is evident from Columella, and the practice has probably considerable utility, especially in dry situations.

WATERING-Syringe, in *Gardening*, a large kind of garden syringe employed for throwing water to some height over trees or plants, in rather a forcible manner, in the way of a stream, for clearing away insects and other matters, as well as some other purposes.

WATERING *the Soil of Tillage Land, in Agriculture*, the practice of improving ploughed ground, and the crops upon it, by the application of water.

The outlines of a plan for watering arable or tillage crops and lands, that has long been familiar to the writer on the Management of Land, are first to form the soil into flat beds or ridges, with intervals, or trenches, directed somewhat obliquely across the slope, or general descent of the field or ground; namely, so as to dip from one quarter to one half *per cent.* beneath the dead level; this declination being equally calculated to communicate and carry off water. The width of the beds is to be regulated by the nature of the land. Absorbent soils may be laid into wider beds than those which are repellent, or of the stiff heavy kind, that are less prone to draw away the water.

The depth of the trenches should vary according to the quality of the water, and the intention of using it. For merely moistening the land, in a dry season, with ordinary water, the trenches, it is conceived, should be deep, so as to lodge the water in the subsoil, rather than the soil above it. But when an enriched water is to be used to fertilize the soil, and encourage the growth of the crop during its early stages, it requires to be communicated immediately to the pasture of the plants; consequently, in this case, the beds should be narrow, and the trenches no deeper than just to prevent the water from overflowing.

When the water is necessarily required to be conducted to the uppermost corner of the field or open ground, to be continued and conducted down the slope, across the higher ends of the beds, and to be forced into the trenches, by the means of regulated checks, placed below their mouths, as occasion may require; it should be either suffered to run with moderate streams along the trenches; or, if the quantity be small in proportion to the extent of ground, it may be checked at proper distances, so that the whole of it shall be absorbed, thus going over the ground, and repeating the watering as the quantity of water, or the sufficiency of moisture may direct.

WATERING, in the *Manufactures*. To water a stuff is to give it a lustre, by wetting it lightly, and then passing it through the press, or the calender, whether hot or cold. See **TABBING**.

WATERLAND, DANIEL, D.D. in *Biography*, was born in 1683, at Wasely, in Lincolnshire, where his father was rector, and sent to Magdalen college, Cambridge, in 1699, for the completion of his education; of this college he was elected a fellow in 1704, took his degree of M.A. in 1706, and became a private tutor. His tract, entitled "Advice to a young Student, with a Method of Study for four Years," published at this time, was popular, and passed through several editions. In 1713 he was nominated master of his college, and presented to the rectory of Ellingham in Norfolk. On occasion of taking his degree of B.D. in 1714, he distinguished himself by defending before the regius professor of divinity the negative of his thesis, "Whether Arian subscription be lawful?" Being chosen chaplain in ordinary to king George I., he was nominated, on his majesty's visit to Cambridge, D.D., and incorporated in the same degree at Oxford. Distinguished as a champion of orthodoxy by his "Vindication of Christ's Divinity, being a Defence of some Queries relating to Dr. Clarke's Scheme of the Holy Trinity," printed in 1719, he was appointed in the following year the first preacher of lady Moyer's lecture in favour of the divinity of Christ. He also published an answer to Dr. Whitby on the same subject, and in 1721 he was presented by the dean and chapter of St. Paul's with the rectory of St. Austin and St. Faith. His "History of the

Athanasian Creed," vindicating it against the objections of Dr. Clarke, was published in 1723, and his preferments to the canonry of Windsor, the vicarage of Twickenham, and the archdeaconry of Middlesex, kept pace with his publications of this nature. His remarks on Dr. Clarke's "Exposition of the Church Catechism," printed in 1730, engaged him in a controversy with Dr. Sykes on the sacrament of the Lord's supper. Against Tindal's "Christianity as old as the Creation," he published his "Scripture Vindicated," and his "Christianity Vindicated against Infidelity." On these treatises, Dr. Middleton published remarks, and they were defended by Dr. Zachary Pearce. In 1734 Dr. Waterland made an attempt for refuting Dr. Clarke's opinions in a "Discourse of the Argument *à priori* for proving the Existence of a First Cause;" and in this year, having declined the office of prolocutor of the lower house of convocation to which he was chosen, he published his treatise "On the Importance of the Doctrine of the Trinity," which he regarded as fundamental, avowing his high respect for the authority of the fathers in this and other articles of faith. In 1736 he commenced a series of archdiaconal charges on the subject of the eucharist, arguing against the opinion of Hoadley on the one hand, that it was a mere communicative feast, and against that of Johnson and Brett, on the other, that it was a proper propitiatory sacrifice. But a complaint under which he laboured, and which required repeated surgical operations, endured by him with exemplary patience, at length terminated his life in December 1740, in the 58th year of his age. A collection of his sermons was published after his death. "As a controversialist," says one of his biographers, "though firm and unyielding, he is accounted fair and candid, free from bitterness, and actuated by no persecuting spirit." Gen. Biog.

WATERLAND, in *Geography*, an island in the South Pacific ocean, discovered by Le Maire and Schouten, in the year 1616. It is represented as a low uninhabited island, sandy, and full of rocks, with plenty of trees on the border, but neither cocoa-nuts nor palmettoes. Some cresses and Indian salad were found, and some fresh water in ditches. No soundings for anchorage were discovered. S. lat. 14° 46'. W. long. 149° 30'.

WATERLANDIANS, in *Ecclesiastical History*, a sect of those that were called the gross or moderate Anabaptists, consisting at first of the inhabitants of a district in North Holland, called *Waterland*; whence their name. They were also called *Johannites* from John de Reis, who, assisted by Lubert Gerard, composed their confession of faith in 1580. This confession far surpasses, in respect both of simplicity and wisdom, all the other confessions of the Mennonites; though it has been alleged, that it is not the general confession of the Waterlandians, but that merely of the congregation, of which its author was the pastor.

This community, says Mosheim, has abandoned the severe discipline and singular opinions of Menno, whom, nevertheless, they generally respect as their primitive parent and founder. They are, however, divided into two distinct sects, which bear the respective denominations of *FREISLANDERS* and *Waterlandians*; and are both without bishops, employing no other ecclesiastical ministers than presbyters and deacons. Each congregation of this sect is independent on all foreign jurisdiction, having its own ecclesiastical council or consistory, which is composed of presbyters and deacons. The supreme spiritual power is, nevertheless, in the hands of the people, without whose consent nothing of importance can be carried into execution. Their presbyters are, generally speaking, men of learning, and apply themselves with success to the study of physic and philosophy; and there is a public professor,

feſſor, ſupported by the ſect at Amſterdam, for the inſtruction of their youth in the various branches of philoſophy, and ſacred erudition. One of theſe Waterlandian ſects was divided, in 1664, into two factions, of which the one were called GALENISTS, and the other APOSTOOLIANS, from their reſpective leaders. Moſheim's Eccl. Hiſt. vol. iv. vol. v.

WATERLOO, ANTHONY, in *Biography*, a Flemiſh landſcape painter of great abilities, is generally ſuppoſed to have been born at Utrecht, about the year 1618; it is certain that he reſided there the greater part of his life, and the ſcenery of his pictures is found in the environs of that city.

His landſcapes are characterized by the greateſt ſimplicity of compoſition; the entrance into a foreſt, a broken road with a bank and a few trunks of trees, a ſolitary cottage, a mill, &c. are made intereſting by the exquisite touch, and beautiful colour and chiaro oſcuro, with which he treated them. His ſkies are clear, and his clouds float in air; his colouring, however, is ſometimes too ſtrongly contraſted with yellow foregrounds and blue diſtances, and offend the eye for want of being more broken. He marked the characters of his trees admirably, in form and colour. His pictures are by no means common, as they are not numerous. He occupied himſelf very much in etching his own deſigns and views, and his productions in that art are as valuable as his pictures, in point of truth and ſkill; and will always continue to be a ſource of pleaſure and improvement to the artiſt and the connoiſſeur. His plates, according to Bartſch, amount in number to 150, not entirely completed with the point, but finiſhed with the graver, to ſoften and to invigorate them. It is to be lamented that he ſunk an early prey to habits of intemperance.

WATERLOO, in *Geography*, a village of the Netherlands, between 12 and 13 miles from Bruffels, ſituated behind the ſkirts of the fine beech foreſt of Soignies, rendered famous by one of the moſt ſevere and ſanguinary battles which modern hiſtory of war records, fought in its vicinity on Sunday the 18th of June, 1815, between the duke of Wellington, who commanded the Britiſh, Hanoverian, German, and Belgic army, and Napoleon Buonaparte, who conducted the operations of the French forces. The ground on which the battle was fought is ſaid not to exceed two miles from north to ſouth, including the whole from the rear of the Britiſh to the rear of the French poſition; and from eaſt to weſt, from the extremity of the left to that of the right wing of the contending armies, is about a mile and a half in extent; ſo that the ſanguinary reſult of the battle has been attributed in ſome degree to the limited ſpace in which they were engaged, and the conſequent intermixture of the two armies. The poſition of the French troops is repreſented as the beſt, becauſe the eminence occupied by them was higher, and the aſcent ſteeper than ours, and better adapted to attack and defence. The village of Waterloo, which is not ſeen from the field of battle, was occupied on the Saturday night previous to the battle by the duke of Wellington, the principal officers of his ſtaff, the prince of Orange, lord Uxbridge, ſir Thomas Picton, ſir William de Lancey, and other general officers. The French army in the Netherlands, is ſaid to have amounted to 130,000; and after the loſſes of the 15th and 16th, and the detachment of two corps under marſhal Grouchy, there muſt have remained at leaſt 90,000 men, with which Napoleon took the field on the 18th of June; while, after allowing for the loſſes of the allies on the 16th, which were very ſerious, it muſt appear that there was a great diſparity in regard to numbers; as it may be deduced from a ſtatement,

founded upon the lateſt return to the Horſe Guards, previous to the battles of the 16th and 18th, that the extreme force Britiſh and German was 46,221 men, under the duke of Wellington, to which we may add 22,000 for Brunſwickers and Dutch, ſo that the whole could not exceed 68,221 men; or, as it is elſewhere ſtated, there could not be in action a greater number than 64,000 men to ſupport the attack of the whole French army. From the adjutant-general's office, 6th November 1816, it appears that the effective ſtrength of the Britiſh army, preſent at the battle of Waterloo on the 18th of June 1815, was 74,040, including the army of obſervation. It is moreover obſerved, that the hoſtile army conſiſted of the beſt troops of France; that it was a regular and diſciplined army, even before the Bourbons quitted France, and that from the return of Buonaparte every thing had been done to render it effective; it was indeed the force which had been ſelected and combined to act upon the northern frontier. Whereas the allied army, the Britiſh part excepted, was almoſt wholly a green army; the allies, particularly the Dutch, Belgians, Hanoverians, and troops of Naſſau, being chiefly young ſoldiers.

Previously to the grand and deciſive battle of Waterloo, the campaign had commenced on the 15th of June by an attack upon the outpoſts of the Pruſſian army, commanded by field-marſhal prince Blucher. The points of concentration of the ſeveral corps of his army were, Fleurus, Namur, Ancy, and Hannut. Buonaparte advanced the ſecond corps of his army by Thuin, along the banks of the Sambre, upon the town of Charleroi, and drove the advanced poſts of general Ziethen's corps back upon the bridge of Marchienne. After a very ſmart action, the Pruſſian general was obliged to retire behind the river, and collect his corps near Fleurus; and as he conſidered Charleroi untenable, the troops ſtationed in that town were withdrawn, and the French cavalry entered it about mid-day. The Pruſſians defended their advanced poſts with bravery; and it was only the overwhelming force that was brought againſt Ziethen's corps, which induced that general to withdraw his advance, in order that he might concentrate his whole force near Fleurus.

On the evening of this day an officer arrived at Bruffels from marſhal Blucher, to announce that hoſtilities had commenced. The duke of Wellington received his diſpatches, whiſt he was ſitting after dinner with a party of officers. The troops were ordered to hold themſelves in readineſs, to march at a minute's notice. Before midnight a ſecond officer arrived from Blucher, and the diſpatches were delivered to the duke of Wellington in the ball-room of the duchefs of Richmond; and he gave his orders to one of his ſtaff-officers, who inſtantly left the room. In the midſt of the reſt that ſeemed to reign over Bruffels, the drums ſuddenly beat to arms, and the loud call of the trumpet was heard from every part of the city. The whole town became inſtantly an univerſal ſhow of buſtle. The ſoldiers aſſembled with their knapſacks, and every kind of warlike preparation threw the town into a ſtate of agitation. But before eight in the morning, the ſtreets, which had been filled with buſy crowds, were empty and ſilent; the great ſquare of the Place Royale, which had been filled with armed men, and with all the appurtenances of war, was now quite deſerted. The duke of Wellington had ſet off in great ſpirits, obſerving, that as Blucher had moſt probably ſettled the buſineſs, he ſhould perhaps return to dinner.

When the direction by which Buonaparte intended to penetrate into Belgium had been aſcertained, the duke of Wellington immediately gave orders for the army under his command

command to concentrate on the extreme of its position, near the great road from Brussels to Charleroi, and in a line between Nivelles and Namur. The fifth division of the British army, with the corps of the duke of Brunswick-Oels, left Brussels about 2 A. M. on the 16th, and advanced towards the position where the whole army was ordered to assemble.

One brigade of the Dutch troops, which was in advance towards Charleroi, had been attacked, when the Prussians fell back on the 15th, and driven from its advanced position near Frasnes; but the prince of Orange having moved up another brigade of the same army, they were able to repulse the enemy, and in the evening they regained the greater part of the ground which had been lost throughout the day. On the morning of the 16th, prince Blucher, who was determined to meet Buonaparte with all his strength, had posted the army under his command on the heights between the villages of Brie and Sombref, and to some distance beyond Sombref. In front of this line, he occupied the villages of St. Amand and Ligny with a very considerable force.

Buonaparte, as soon as he had passed the Sambre, directed the great body of his force against the Prussian line. Marshal Ney, who commanded the left wing, was directed to advance by Gosselies and Frasnes, and attack the British position; his force consisting of the first and second corps of infantry, and four divisions of cavalry.

The third, fourth, and sixth corps, with the guard in reserve, were ordered to attack the Prussian position in front, while the fifth corps under Grouchy, and a division of cavalry, were detached towards Sombref, on the Namur road, with the view of manœuvring on that flank.

On debouching from Fleurus, Buonaparte had an opportunity of reconnoitring the position of marshal Blucher with more precision. He immediately placed the first corps belonging to the left wing under Ney, with two divisions of heavy cavalry, behind the village of Frasnes, on the right, and at a little distance from the Brussels road, where it was to form a reserve, that could be brought up to support either his attack upon the Prussians, or Ney's attack upon the British. The third corps was ordered to advance in column to carry the village of St. Amand, while the fourth corps, supported by the guard and the cavalry, was ordered to attack Ligny.

The enemy advanced in overpowering masses upon St. Amand, where the action first commenced on the morning of the 16th. The brave Prussians defended this part of their advanced position with great firmness, and it was not till after a long and sanguinary conflict, that they were obliged to yield for a time to superior numbers. The fourth corps commenced its attack upon the village of Ligny about mid-day, and by one o'clock P. M. the action may be said to have become general throughout the whole of the extended line of the allied British and Prussian armies. Grouchy by that time had attacked the extreme left beyond Sombref, and Ney had come in contact with the advance of the army under the duke of Wellington, near Frasnes. But it was in the villages of St. Amand and Ligny, that the greatest struggle for victory took place, between the contending armies. There the battle continued for five hours, it may be said, almost in the villages themselves, as the movements forwards and backwards, during that period, were confined to a very narrow space. Fresh troops were constantly moved up on both sides; and as each army had immense masses of infantry behind that part of the village which it occupied, these served to maintain the combat, as they were continually receiving reinforcements from the

rear. Upwards of 200 pieces of cannon were directed against the villages, and they were frequently on fire in many places.

About 4 o'clock, prince Blucher placed himself at the head of a battalion of infantry, and charged with them into the village of St. Amand. After a dreadful struggle, he gained possession of the greater part of it. The enemy were panic-struck, and the victory seemed so doubtful, that Buonaparte was obliged to send in all haste for the first corps, which he had left in reserve near Frasnes; at the very moment too, that it had become equally necessary to marshal Ney, whose columns, having been repulsed by the fifth division of British infantry, were retiring in great confusion.

The advantage which Blucher had so nobly gained, was of little importance to the general action in which his troops were engaged. At Ligny, the battle still raged with unabated vigour; and though the evening was far advanced, the victory remained undecided. The badness of the roads, and the difficulties which general Bulow had to encounter in his march, prevented his corps from getting up on the 16th; so that Blucher had only three corps of his army in position; and though they had repulsed every attack which had been made upon them, the danger was becoming urgent, as all the divisions were engaged, or had already been so, and there was no reserve at hand.

As the night advanced, the enemy, favoured by the darkness, made a circuit round the village of Ligny, with a division of infantry on one side; and, without being observed, got into the rear of the main body of the Prussian army, at the same moment that some regiments of cuirassiers forced their passage on the other side of the village. This movement decided the day, and field-marshal Blucher was obliged to commence his retreat; yet his brave columns, though surprised, were not dismayed. They formed themselves into solid masses, and, repulsing every attack which the enemy made upon them, retired in perfect good order to their original ground, upon the heights above the village, and from thence continued, unmolested, their retrograde movement upon Wavre.

This movement of the marshal's rendered necessary a corresponding one on the part of the duke of Wellington; and he retired from the farm of Quatre Bras upon Genappe, and thence upon Waterloo, the next morning of the 17th at 10 o'clock.

The duke of Wellington, having given orders for the army under his command to concentrate on the left, proceeded with the fifth division and the duke of Brunswick-Oels' corps, in the direction of Charleroi. About two o'clock on the afternoon of the 16th, the head of the British column reached the farm of Quatre Bras, so named from its standing near where the roads from Brussels to Charleroi, and from Nivelles to Namur, cross each other. The advance of the enemy under Ney, who had again driven the Dutch troops from their position near Frasnes, had nearly reached the same spot; and general Kempt's brigade had scarcely time to deploy from the great road, before it was attacked by the enemy's cavalry, supported by heavy masses of his infantry. Nothing could exceed the daring intrepidity of the French troops at this moment; their success on the 15th, and confidence in their leader, added to the natural bravery of the troops, made them advance with almost a certainty of victory. The sudden appearance of overwhelming masses of cavalry, and the rapidity with which they charged our infantry, before they had time to throw themselves into squares, created some little confusion in one or two regiments. Indeed, so daring were the

WATERLOO.

French cuirassiers, that a regiment actually cut into the square of the forty-second Highlanders; but they paid dear for their temerity, as few ever returned to their lines; and the Highlanders had ample revenge for the loss of their brave colonel sir Robert Macara. The third battalion of the Royal Scots, twenty-eighth, and first battalion of the ninety-fifth, were warmly engaged for several hours on the left of the Brussels road; while general Pack's brigade, consisting of the forty-fourth, seventy-ninth, and ninety-second regiments, with the forty-second already mentioned, succeeded completely in repelling the enemy on the right, after an equally arduous contest.

About 4 o'clock, the first division under major-general Cooke, and third under lieutenant-general sir Charles Alten, came up, and were also immediately engaged. The enemy was now driven from his ground, and obliged to retire to the position which he had occupied the night before, and where he had some difficulty in maintaining himself, until the darkness put an end to the combat. The troops of the duke of Brunswick distinguished themselves very much on the afternoon of the 16th; and his serene highness was unfortunately killed at the head of his brave hussars.

At day-light on the morning of the 17th, the duke shewed his whole force, and challenged the enemy to fight; but they did not seem disposed to accept the challenge; and therefore both he and prince Blucher took up their respective positions; their movements having been communicated to each other, and Blucher having been requested to support the duke in case of an attack on the next day with two divisions of his army. On the 17th no movement of any consequence took place.

The position which the British army now took up, had been chosen with great judgment, from its proximity to the extensive forest of Soignies. The village of Waterloo lies upon the great road from Brussels to Charleroi, embosomed in the forest; and a few scattered houses extend to another small village called Mont-Saint-John: about a quarter of a mile in front of this latter village, there is a rising ground which crosses the great road already mentioned, and extends from a farm-house called Ter-la-Haye on the left, to the village of Merbe-le-Braine on the right, crossing also the road from Brussels to Nivelles, which diverges from the road to Charleroi at the village of Mont-Saint-John. It was on this rising ground that the allied army, commanded by field-marshal the duke of Wellington, or more properly the first corps of that army, took up its position on the evening of the 17th of June. The second corps, under the command of lord Hill, (with the exception of the fourth division and the troops of the Netherlands, under prince Frederick of Orange, who were left to guard an important position at Halle,) was placed in reserve on the right of the position, and in front of the village of Merbe-le-Braine, with its right resting on Braine-la-Leud. The infantry bivouacked a little under the ridge of the rising ground, and the cavalry in the hollow ground in rear of the infantry. Excepting a few round shot which the enemy occasionally fired while our troops were deploying into their position, nothing of any moment occurred during that afternoon or the whole of the night.

It had rained almost incessantly during the greater part of the 17th, and the weather was very tempestuous during the night. The ground afforded no cover for the troops; so that generals, officers, and men, were equally exposed to the rain, which fell in torrents. Buonaparte slept at the farm-house of Caillou near Planchenois; and his army halted in the neighbourhood of Genappe. The duke of

Wellington slept at a small public house in the village of Waterloo.

As soon as day-light appeared on the morning of the 18th, the British army could perceive, from its position, immense masses of the enemy moving in every direction, and before two o'clock the whole of his force appeared to be collected on the heights and in the ravines, which ran parallel with the British position.

The French army, when concentrated in front of the position of the allies, consisted of four corps of infantry including the guard, and three corps of cavalry, the whole number of men being uncertain, and probably overrated by those who state them at 120,000.

At 11 o'clock every thing seemed to indicate that the awful contest would soon commence;—a contest in which victory was obliquely and valiantly disputed on both sides, but which at last terminated in the complete triumph of the duke of Wellington, and total defeat and political annihilation of Buonaparte. The weather had cleared up, and the sun shone a little as the battle began, and the armies within 800 yards of each other, the duke of Wellington, with his usual quickness, had soon perceived the nature of the attacks that would be made upon his line; and when the troops stood to their arms in the morning, he gave orders that they should be formed into squares of half battalions, and in that state await the enemy's attack.

Marshal Ney, as soon as Buonaparte's order was communicated to him, directed the division of infantry commanded by Jerome Buonaparte, to advance upon Hougoumont; and about half past eleven o'clock, the first columns of this division made their appearance upon the ravine, or rather hollow ground, which leads down from the public-house of La Belle Alliance to the Chateau. The two brigades of artillery belonging to general Cooke's division had taken up a position on the ridge of the hill in front of the line of infantry, and the moment the enemy made his appearance, our nine-pounders opened upon his columns. The artillery officers had got the range so accurately, that almost every shot and shell fell in the very centre of his masses; so great was the effect produced by these few guns, that all Jerome's bravery could not make his fellows advance, and in a moment they were again hid by the rising ground from under cover of which they had but just emerged. This, which was the commencement of the action, was considered a very favourable omen by our brave fellows who witnessed it; and for a short time they were much amused with the manœuvres of Jerome's division, and the cautious manner in which it seemed to emerge from its hiding-place.

This state of things, however, did not continue long, as other great movements were observed to be preparing throughout the enemy's line. A powerful artillery was brought to bear upon our guns that had so annoyed his first advance, and general Jerome's troops gained the outskirts of the wood, where they became engaged with our light troops. By mid-day the cannonade was general.

The great object of Buonaparte, in this important battle, was evidently to force our centre, and at the same time turn our right flank; so that by surrounding and taking prisoners, as it were, one half of our line, he might completely paralyse and destroy the effect of the other half. Unfortunately, our centre was the weakest part of our position, and upon that part he directed his first grand attack to be made about noon.

An immense mass of infantry, followed by a column of upwards of twelve thousand cavalry, advanced upon the points occupied by the third and fifth divisions, and the left

of the Guards, covered by a fire from upwards of one hundred pieces of artillery. These columns, which seemed to advance with a certainty of success, were led by count d'Erlon in person. They advanced almost to the muzzles of our muskets; but here they soon found they had Britons to contend with; our fellows gave them a volley; and, cheering, rushed on to the charge, which they did not stand to receive, and our cavalry emerging from the hollow ground where they had hitherto been concealed from the enemy's view, passed through the openings between the squares, and charging the enemy's cavalry, succeeded completely in dispersing them, and driving them back upon their own line.

In this conflict, which was dreadful while it lasted, the enemy was baffled in all his attempts, and, besides the killed and wounded, lost several thousand prisoners and an eagle; but the British army had also to lament the loss of its brightest ornaments, and his majesty, one of his best officers. The gallant sir Thomas Picton fell, mortally wounded, in leading on the fifth division.

About 3 o'clock, when Buonaparte found that Jerome's division could not drive the guards from Hougomont, he ordered the chateau to be set on fire. The shells from several mortars which were brought to bear upon the houses, soon had the desired effect: but our troops, retiring into the garden, did not yield one inch of their ground; and the only thing which the enemy gained by this cruel measure, was the destruction of a few of our wounded, who were too ill to be removed, and who fell a prey to the flames. The troops in La Haye Sainte, having expended their ammunition, were obliged to retire for a moment from that point, and the enemy got possession of the house and garden; but as soon as a reinforcement of our troops could be moved up, he was driven from that as well as from every other point which he had attacked: and at no period during the day, notwithstanding the heavy masses of infantry and cavalry which were advanced against our centre, time after time, was he ever able to force our position; and the possession of the advanced post of La Haye Sainte for a few minutes, may be said to have been the greatest advantage he ever gained. The battle continued to rage with unabated fury, and the number of brave men who were continually falling on both sides was very great, while the rapidity with which the columns of attack succeeded each other, seemed to indicate for a time, that the resources of the enemy were inexhaustible. The artillery on both sides was well served: but Buonaparte had upwards of two hundred and fifty pieces in the field; while the train of the allied army under the duke of Wellington did not exceed one hundred guns, nine-pounders and six-pounders. Notwithstanding our inferiority in this arm, which was still more apparent from the size of the enemy's guns (being twelve-pounders) than from their numbers, ours were so well fought, that it is allowed by all, they did equal execution.

About 2 o'clock, the duke of Wellington dispatched an officer of his staff to the head-quarters of field-marshal Blucher, to ascertain his movements, and to know when it was probable his advance would come in contact with the enemy. This officer found the Prussian general at the village of Lasnes, where he gained the information required.

At half past 7 o'clock, the issue of the battle was still doubtful. The greater part of lord Hill's corps of the British army had been moved up at different periods to the support of the first corps. The whole of Bulow's corps, and part of the second corps of the Prussian army, had arrived at their position near Frichermont, and their attack in that direction was sufficiently powerful to oblige the

enemy to give way on his right; which Buonaparte having observed, conceived that the moment was now arrived when he must put an end to the engagement. He informed his generals that the firing on the right was occasioned by the arrival of Grouchy's corps. This gave fresh hopes to his troops already beginning to despair, and immediately he gave orders to form the last column of attack. This column was composed principally of the guard, which had hitherto suffered but little; he gave directions for the whole of the line to second this effort, upon which he said the victory depended, and placing himself at their head, they advanced in double quick time.

These veteran warriors, so long esteemed the first troops in Europe, advanced across the plain which divided the two armies, with a firmness which nothing could exceed; and though our grape and canister shot made dreadful havoc in their ranks, they were never disconcerted for a single moment. Our infantry remained firm in their position, until the enemy's front line was nearly in contact with them, when, with the usual salute of a well-directed volley, and a British cheer, they rushed on to the charge with bayonets. This charge even the Imperial guard could not stand against, and those undaunted troops, who at one time considered themselves the conquerors of the world, were obliged to give way. In this attack the British and French guards were, for the first time, perhaps, fairly opposed to each other. The shock for a moment was dreadful. The enemy refused to take or give quarter, and the carnage was horrible. At last the whole of their ranks was broken, all discipline was at an end, and they began to give way in the utmost confusion. The duke of Wellington, who was on the spot, was not inattentive to the manner in which the enemy retired from this attack, and, though his left was still pressed, he ordered the whole line of infantry, supported by the cavalry and artillery, to advance. This order was no sooner given, than our brave fellows rushed forward from every point. In a moment they carried the enemy's position, and obliged him to retire in great disorder, leaving in our possession a number of prisoners, and upwards of one hundred and fifty pieces of cannon, with their ammunition, besides two eagles. Before the disorganized masses of the French had cleared the ravine by which they retired, the right and left of the British line were nearly in contact, and the enemy in a manner surrounded. What added greatly to the confusion of the beaten foe, was a gallant charge by general Ziethen's corps upon his right flank, at the moment the British advanced in front. Blucher, who had joined with his first corps at the time this decisive charge was going on, advanced with his gallant troops; and about nine o'clock the two field-marsals met at the small public-house called La Belle Alliance, and mutually saluted each other as victors.

The British army, which had been so warmly engaged for upwards of nine hours, was now halted, and the pursuit left to the brave Prussians. Though they had already marched many leagues, all fatigue was forgotten when in the presence of their enemy. About half-past nine field-marshal Blucher assembled the whole of his superior officers, and gave orders for them to send every man and horse in pursuit.

It is not easy to ascertain the number of those who were killed and wounded, from the 15th to the 18th days of June inclusively. The loss of the guards, in killed and wounded, in the defence of Hougomont, amounted to 28 officers, and about 800 rank and file. The foreign corps (Nassau and Brunwickers) lost about 100. Within half an hour, it is said, 1500 men were killed in the small orchard

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of about four acres at Hougomont. The loss of the French was enormous. The division of general Foy alone lost about 3000, and their total loss in the attack of this position is estimated at 10,000 in killed and wounded. Above 6000 men of both armies perished in the farm of Hougomont; 600 French fell in the attack on the chateau and the farm; 200 English were killed in the wood; 25 in the garden; 1100 in the orchard and meadow; 400 near the farmer's garden; 2000 of both parties behind the great orchard. The bodies of 300 English are buried opposite the gate of the chateau; those of 600 French have been burnt at the same place. The wounded at Quatre Bras, 16th of June, are stated upon the report of the adjutant-general, to be 5000; but no estimate is given of the killed, who must have been very numerous. On occasion of Blucher's retiring to Wavre, he is said to have had 14,000 men killed and wounded. The loss of the British, as stated in a letter dated June 19th, since the 16th, must have exceeded 5000. In the battle of Ligny and Quatre Bras, Napoleon is said to have lost 10,000 men. The total of the killed and wounded of the British soldiers, as returned from the War-office July 1815, amounts to 9755 persons. The total of the killed, wounded, and missing of the royal artillery in the battles of the 16th and 18th of June 1815, comprehends 32 officers, 15 serjeants, 285 rank and file, and 529 horses. The loss of the Dutch in killed, wounded, and missing, is stated to be 4136. The Prussians are said to have lost 33,120.

According to the French accounts their loss, at the battle of Fleurus on the 15th, was 10 killed and 80 wounded, and that of their enemy 2000, of whom 1000 were prisoners. The loss of the Prussians on the 16th could not be less, as they say, than 15,000 men, and their own 3000 killed and wounded. At Quatre Bras they say, that the English lost from 4 to 5000 men; and that theirs, which was very considerable, amounted to 4200 killed and wounded. They make no statement of that of the 18th.

The total loss of the British, Hanoverians, and German legions from official reports, from June 16th to the 26th, 1815, is 11,084; and the computed losses of the Dutch and Prussians during the campaigns in the Netherlands were, that of the Dutch as above stated 4136, and that of the total Prussian loss 33,132.

It appears from the list of killed and wounded from the official returns, June 16 to June 26, 1815, that an immense number of officers, several of whom were high in rank, is included in one or other of these classes. In the former, are the names of the duke of Brunswick-Oels, colonel Cameron, lieutenant-colonel Canning, lieutenant-colonel sir F. d'Oyly, colonel sir H. W. Ellis, lieutenant-colonel sir A. Gordon, colonel sir W. de Lancey, and colonel sir R. Macara, lieutenant-general sir T. Picton, major-general sir W. Ponsonby, &c. &c.; and in the latter we find the prince of Orange, the earl of Uxbridge, colonel Hon. A. Abercromby, lieutenant-general sir C. Alten, major-general sir E. Barnes, major Beckwith, lieutenant sir H. Berkeley, lieutenant-colonel sir H. Bradford, major Cameron, lieutenant-colonel Cameron, lieutenant-colonel R. H. Cooke, colonel sir J. Ellay, captain Hon. E. S. Erskine, lieutenant-colonel sir R. C. Hill, lieutenant-colonel Macdonald, colonel Hon. F. Ponsonby, lieutenant-colonel Fitzroy Somerset, earl of Uxbridge, &c. &c.

After the most diligent research, amidst confused and contradictory accounts, it is difficult, if not impossible, to ascertain the exact number of the killed and wounded, on both sides, in this sanguinary and decisive conflict.

Honourable and prosperous as was the issue of this battle,

we cannot forbear regretting that so many valuable lives should be sacrificed on occasions of this kind, and we also lament the condition of those who are wounded and maimed, and rendered helpless for the residue of their years. We applaud the spirit that has actuated such multitudes, and disposed them to confer honour on the name and memories, or to impart to the succour and supply, of those who have fallen or suffered in the service of their country.

The singular importance of this victory, the pre-eminent talents of the commander-in-chief, and the heroism displayed by the officers, commissioned and non-commissioned, and by all the privates, on this interesting occasion, entitled them to the gratitude of the government and of the country, and to such tokens of respect as were thought to be most appropriate to the occasion. Accordingly, it was resolved on the 23d of June, that the thanks of both houses of parliament should be given to his grace the duke of Wellington, prince Blucher, and the allied armies, officers and soldiers. The prince regent also granted the dignity of a marquis to earl Uxbridge and his heirs. The house of commons agreed June 29th 1815, in an address to the prince regent, requesting him to direct a national monument to be erected in honour of the splendid victory of Waterloo, and to commemorate the fame of the officers and men of the British army, who fell gloriously upon the 16th and 18th of the said month; and more particularly of lieutenant-general sir Thomas Picton, and major-general the Hon. sir William Ponsonby; and that funeral monuments be also erected in memory of each of these two officers in the cathedral church of St. Paul, London. The prince regent has also been pleased, in the name and on behalf of his majesty, to grant promotion to 52 majors, recommended for brevet-rank, for their conduct in the battle of Waterloo, to be lieutenant-colonels in the army; and to 36 captains to be majors, with commissions respectively, dated from June 18, 1815. His royal highness has also appointed major-general sir James Kempt, to be knight grand cross of the most honourable military order of the Bath; and major-generals G. Cooke, Maitland, and F. Adam, to be knights commanders of the said order, and a number of other officers to be companions of the most honourable military order of the Bath, upon the recommendation of the duke of Wellington. The king of the Netherlands has given the duke of Wellington the title of prince of Waterloo, and the states-general have settled upon his family an estate annually producing 20,000 Dutch florins, (2000*l.*) consisting of woods, &c. in the neighbourhood of La Belle Alliance, Hougomont, &c. The king of Saxony has also conferred upon the duke his family order of "The Crown of Rue;" and the grand duke of Baden has conferred upon him his order of "Fidelity" of the first class, accompanied with a gold snuff-box, enriched with diamonds of great value. The emperor of Austria has conferred upon a number of officers the cross of a commander, and of a knight respectively of the order of "Maria Theresia." The emperor of Russia has also conferred decorations of different classes of the orders of St. George, Anne, and Wladimir, on a number of officers. The king of the Low Countries has also conferred decorations of different classes of the "Wilhelm's" order upon certain officers. The king of Bavaria has conferred decorations of the different classes of the order of "Maximilian Joseph," on certain officers; all these in testimony of their respective approbation of their services and conduct. The prince regent has granted the dignity of a baron of the United kingdom of Great Britain and Ireland unto the right honourable lieutenant-general Rowland baron Hill and to his heirs; and in token of his high approbation of the distinguished bravery and

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and good conduct of the first and second life-guards at the battle of Waterloo, he has declared himself colonel in chief of both these regiments. He also declares that he shall approve all the British regiments of cavalry and infantry which were engaged in the battle of Waterloo, being permitted to wear on their colours and appointments, in addition to all other badges and devices, the word "Waterloo," in commemoration of their distinguished services on the 18th of June 1815; and he also approves of all the ensigns of the three regiments of foot-guards having the rank of lieutenants, and that such rank shall be attached to all the future appointments to ensigncies in the foot-guards, in the same manner as the lieutenants of those regiments obtain the rank of captain; and he also approves of the first regiment of foot-guards being a regiment of grenadiers, and styled "The First or Grenadier Regiment of Foot-Guards." An alteration has also taken place in regard to the pensions allowed to wounded officers in favour of those who have served in the battle of Waterloo; and it is also ordered that henceforth every non-commissioned officer, trumpeter, drummer, and private man, who served in the battle of Waterloo, or in any of the actions which immediately preceded it, shall be borne upon the muster-rolls and pay-lists of their respective corps as "Waterloo Men;" and that every "Waterloo Man" shall be allowed to count two years' service in virtue of that victory, in reckoning his services for increase of pay, or for pension when discharged.

It is also ordered, that the lieutenants of cavalry and infantry, who had served more than five years as such, on the 18th of June 1815, or who may subsequently have completed that period of service, are to receive one shilling *per diem* for every day's service as lieutenant beyond five years, it being fully understood that the retrospect is, in no instance, to exceed two years. In like manner, the corporals and privates, distinguished as "Waterloo Men," are to receive the benefit of the two years' service retrospectively, in cases in which, by the addition of the two years, they would have completed their respective terms of service, on or previously to the 18th of June 1815, and the two years' service will, of course, be reckoned in all claims subsequently accruing.

Sir Charles Alten is honoured with the title of count, and the Hanoverian troops, who were present in the battle, may bear on their colours and uniform the word "Waterloo." Other regiments also that are particularly specified, are to have the word "Waterloo" in commemoration of their distinguished services, June 18th, 1815. The prince regent has commanded, that in commemoration of the brilliant and decisive victory of Waterloo, a medal shall be conferred upon every officer, non-commissioned officer, and soldier of the British army, present upon that memorable occasion. It is also appointed, that from the date of the battle of Waterloo, 18th June 1815, the pensions to officers and widows shall increase according to the officer's further advance.

It is a farther instruction with regard to the Waterloo grant, that lieutenants of cavalry and infantry, who had served more than five years on the 18th of June, are to receive one shilling *per day* for every day beyond five years' service, provided the retrospect be not beyond two years: non-commissioned officers and privates are also to benefit proportionately from the same retrospect. The charge for officers is to be made in their ordinary accounts; those for men distinct in a pay list supplementary, according to a prescribed form.

Prize-money was also granted by parliament to the army which served under the command of field-marshal his grace the duke of Wellington in the battle of Waterloo and cap-

ture of Paris. This was advertised in the London Gazette, June 21, 1817. Those shares that have not been claimed before the 24th of September 1817, may afterwards be received from the deputy treasurer of Chelsea hospital, if claimed within the period of six years.

The shares of each individual in the following classes are:

Commander-in-chief's proportion is estimated at	£61,000 0 0
Class 1. General officers	1,274 10 10 ³ / ₄
2. Field-officers and colonels	433 2 1 ³ / ₄
3. Captains	90 7 3 ³ / ₄
4. Subalterns	34 14 9 ¹ / ₂
5. Sergeants	19 4 4
6. Corporals, drummers, and privates	2 11 4

Notice has also been given in the Dutch, Flanders, and German papers, that his highness the prince of Waterloo, duke of Wellington, has given orders for the payment of the prize-money to all the allied troops, who fought under his command at Quatre Bras and Waterloo, at the taking of Paris.

His highness has fixed the proportions into classes as above. This distribution includes the Dutch, Belgic, Nassau, Hanoverian, and Brunswick troops.

The total amount of receipts for the Waterloo subscription to May 31, 1817, has been 518,288*l.* 9*s.* 11*d.* The total expenditure for payments and donations, and incidental charges, leaves a balance at the bankers 18th of June 1817 of 1,222*l.* 13*s.* 5*d.*

Statement of the appropriation is as follows:

<i>Annuities granted for Life.</i>	
To the widows of officers, non-commissioned officers, and privates killed	£9,594
To the wounded non-commissioned officers, and privates totally disabled	1,649
To dependent relatives	540
Amount of annuities for life	11,783
<i>Annuities granted for limited Periods.</i>	
To the children of officers, non-commissioned officers, and privates	8,314
To orphans	895
Amount of annuities for limited periods	9,209
Total amount of annuities	20,992

<i>Voted in Money.</i>	
To the wounded officers, non-commissioned officers, and privates	71,126
To the parents and dependent relatives of officers, non-commissioned officers, and privates killed, leaving no widows or children	28,577

<i>To the Foreign Troops, viz.</i>	
Prussians, Brunswickers	45,000
Hanoverians, and Netherlanders	17,500
Additional for the exclusive benefit of their orphans rendered such by the campaign of 1815	62,500
Total amount voted in money	162,203

A considerable subscription, amounting to 3905*l.* 14*s.* 9*d.* received

received from Demerary, has been lately announced, February 24, 1818.

On the second anniversary of the battle of Waterloo, the noble structure of the bridge over the Thames from Surrey to the site of the Savoy, was first opened for public accommodation; and with a view of commemorating the ever-memorable victory of Waterloo, its name was changed from that of the "Strand Bridge," to the more dignified and triumphal appellation of "Waterloo Bridge." The ceremony was conducted with great dignity and splendour.

This bridge exhibits a very striking display of the eminent abilities and taste of Mr. Rennie, the engineer, as well as of the liberality of the proprietors, who have provided the funds necessary for its construction. Its situation is judiciously selected, as, independently of the advantage which commerce and the convenience of personal intercourse may derive from it, it gives the grandest view we have of the river in its beautiful meander, displays the rising crescent of buildings on the north side, and brings out Somerset Terrace in the most favourable way; while on the south it opens the beautiful prospect of the Surrey hills.

The following are some detailed particulars of the bridge, which is constructed of Cornish granite; the balustrades are of granite from Aberdeen.

Dimensions of the Bridge.

	Feet.
The length of the stone bridge within the abutments	1,242
Length of the road supported on brick arches on the Surrey side of the river	1,250
Length of the road supported on brick arches on the London side	400
Total length from the Strand, where the building begins, to the spot in Lambeth where it falls to the level of the road	2,892
Width of the bridge within the balustrades	42
Width of pavement or foot-way on each side	7
Width of road for horses and carriages	28
Span of each arch	120
Thickness of each pier	23
Clear water-way under the nine arches, which are equal, 120 ft. each	1,080
Brick arches on the Surrey side	40
Ditto on the London side	16
Granite ditto for the water-course	9
Total number of arches from the Strand to the Lambeth level	65

In building the arches, the stones (some of which weigh upwards of six tons) were so accurately jointed and carefully laid, that upon the removal of the centres, none of the arches sunk more than an inch and a half. In short the excellency of the workmanship vies with the beauty of the design, and with the skill and arrangement, to render the "Bridge of Waterloo" a monument of the public spirit, taste, and glory of the age, of which the metropolis, and the British empire, have abundant reason to be proud.

We shall close our account of the battle of Waterloo, with stating a fact not unworthy of being recorded. The states-general desiring to give to his royal highness the prince of Orange a testimony of the national gratitude, for the bravery which he employed, as well in the defence of the position of Quatre Bras as at the battle of Waterloo, have proposed to his majesty, to purchase at the expence of the State a palace, situated in the city of Brussels, which, after being properly furnished, may be given in full property to his royal highness the hereditary prince, as well as the park of Toweuren, in the forest of Soigné, with a hunting-seat;

and that these estates be transferred to the prince of Orange, free of all charges and expence. His majesty approved of this proposal. See *Battle of Waterloo, &c.* 2 vols. 8vo. London, 1817.

WATERMEN are such as row in boats, or ply on the river Thames, ultimately subject to the direction and government of the lord-mayor of London, and court of aldermen, who settle their fares, and, as well as other justices of peace, have authority to hear and determine offences, &c.

The names of watermen are to be registered; and their boats must be twelve feet and a half long, and four and a half broad, or be liable to forfeiture; and watermen, taking more than the fares assessed, shall forfeit 40s., and suffer half a year's imprisonment; and refusing to carry persons for their fare, shall be imprisoned for twelve months. None shall ply on the river, but such as have been apprentices to watermen for seven years. 2 & 3 P. & M. cap. 16. 29 Car. II. cap. 7.

The lightermen and watermen constitute a company; and the lord-mayor and aldermen yearly elect eight of the latter, and three of the former, to be rulers, and the watermen choose assistants; the rulers and assistants being empowered to make rules, which are required to be observed, under penalties. The rulers on their court-days shall appoint forty watermen to ply on Sundays, for carrying passengers across the river, who pay them for their labour, and apply the overplus to the poor decayed watermen; and no persons are allowed to travel on a Sunday with boats, unless they are licensed and allowed by a justice, on pain of forfeiting 5s. 11 & 12 W. III. cap. 21.

No apprentice shall take upon him the care of a boat, till he is sixteen years of age, if a waterman's son, and seventeen, if a landman's, unless he hath worked with some able waterman for two years, under the penalty of 10s.; and if any person, not having served seven years to a waterman, &c. row any boat in the river Thames for hire, he shall forfeit 10l., gardeners' boats, dung-boats, fishermen's, wood-lighters, western barges, &c. excepted. No apprentice is to be taken under fourteen years, who shall be bound for seven years, and enrolled in the book of the watermen's company, on pain of 10l. No tilt-boat, row-barge, &c. shall take more than thirty-seven passengers, and three more by the way; nor any other boat above eight, and two by the way, on forfeiture of 5l. for the first offence, and 10l. for the second, &c. And in case any person be drowned, where a greater number is taken in, the waterman shall be deemed guilty of felony, and transported. 10 Geo. II. cap. 31.

Tilt-boats used between London-bridge and Gravesend shall be fifteen tons, and the other boats three tons. Rulers of the watermen's company are required to appoint two officers, one at Billingsgate at high-water, and another at Gravesend, to ring a bell for the tilt-boats, &c. to put off; and those which do not immediately proceed with two sufficient men, shall forfeit 5l. The fares of watermen, assessed by the court of aldermen, are, from London-bridge to Lime-house, Ratcliffe-crofs, &c. for oars 1s., and scullers 6d.; Wapping-dock, Rotherhithe-church stairs, &c. for oars 6d., and for scullers 3d.; from either side of the water above the bridge to Lambeth and Vauxhall, for oars 1s., and scullers 6d. For all the stairs between London-bridge and Westminster, oars 6d., and scullers 3d.

WATERS, among *Farriers*, the name given to a dis-temperature of horses. See *WATERY SORES*.

WATERSAY, in *Geography*, one of the Western islands of Scotland, about one mile south from South-Uist, from which it is separated by a channel, called "Chifamul Bay." This island is about three miles long, and one broad. N. lat. 56° 54'. W. long. 7° 30'.

WATERTIGHT STUFF denotes clay, or any other tenacious and compact soil, which will hold water.

WATERTOWN, in *Geography*, a town of Massachusetts, in the county of Middlesex, containing 1531 inhabitants; 7 miles W.N.W. of Boston.—Also, a town of Connecticut, in the county of Litchfield, containing 1714 inhabitants; 26 miles N.N.W. of New Haven.

WATERTOWN, a post-township of New York, the capital of Jefferson county, and a place of deposit for the military stores of the state of New York. It lies near the mouth of Black river, about 80 miles N.W. of Utica, and was first created into a town in March 1810, from a part of Mexico, then in Oneida county, and comprised also Rutland and Hounsfield. Its extent is about six miles square. The inhabitants are principally emigrants from the eastern states. Here are about 200 dwelling-houses, eight school-houses, a court-house and gaol, together with a lodge and arsenal for military stores. Here are also eight grist and saw-mills, one paper-mill, one wool-carding machine, five distilleries, two breweries, a printing-office and weekly paper, a small air-furnace, and many common mechanics. It promises to be a place of much business. Pot and pearl ashes are manufactured in abundance, and sent in boats to Montreal. By the census of 1810, the population consists of 1849 persons; and here are 308 senatorial electors.

WATERTOWN, or *Jefferson Village*, is a flourishing post-village of Watertown, in Jefferson county, on the south bank of Black river, four miles from Brownville, and at the same distance from navigable water communicating with lake Ontario. The village contains about 50 dwelling-houses, some of which are elegant. In its vicinity are a quarry of good building lime-stone, clay, and sand. Pine and other timber are plentiful.

WATERVILLE, a town of the district of Maine, and county of Kennebeck, containing 1314 inhabitants.

WATERVLIET, a large township of New York, in the north-east corner of Albany county, 6 miles N. of Albany; extending 10 miles along the Mohawk, and 6½ miles along the Hudson, and having an area of about 52 square miles, exclusive of several islands in the Hudson. Much of the land is poor and barren, and the population is very unequally distributed. Along the Hudson are some fine flats, and in many places the river-hills are moderately steep, and afford good farming lands. The interior abounds with sandy ridges, some marshes, and wet land, wooded with pine and a variety of dwarf shrubbery, of little value. In this township are two small villages, *viz.* Washington, five miles north of Albany, and Gibbon's Ville, opposite Troy, six miles. The Cahoos, which are the principal falls of the Mohawk, are between Watervliet and Halfmoon, in Saratoga county. The whole river Mohawk descends in one sheet at high water, about 70 feet; and below the falls the spreading branches form islands, which are attached to this town: these are Haver island, Van Schaick's island or Cahoos island, and Green island. In this town are 1092 white males, 1070 white females, 128 slaves, and 75 other persons; in all 2365; and 215 senatorial electors. The settlement of the people called "Shakers" lies in the north-west part of this town, at a place called Niskayuna, 8 miles N.W. of Albany. They have a house of worship, and the village contains about 150 houses. A manufactory of iron screws has lately been erected on the Mohawk, near Cahoos bridge.

WATERVLIET, a town of Flanders; 12 miles E. of Sluys.

WATERY HEAD. See **HYDROCEPHALUS**.

WATERY Humour. See **AQUEOUS** and **HUMOUR**.

WATERY Lands, in *Agriculture*, all such as are largely impregnated with and retentive of moisture or wetness.

Wherever water rests much upon lands, it sours them, and destroys the finer herbage; the remaining plants being made to become coarse and strong, but mostly unpalatable, and of little value for stock. They should, of course, have the superabundant water removed from them, and then be improved by suitable substances applied as manures, and by other means, such as being flooded, in some cases.

By such methods, according to the nature of their wetness, such lands may mostly be brought into a good state of improvement. See **BOG**, **FEN**, **MORASS**, **MARSH**, and **SWAMP**; also the lands of their several natures.

WATERY Poke, a name sometimes given to a disease in sheep, from their having a sort of poke or bag hanging below the top of their throats, supposed to be caused by water. See **SHEEP** and **ROT**.

WATERY Sores, diseases of the legs and pasterns of horses and some other animals, in which there are watery swellings and sores, which discharge an acrid watery fluid. They mostly arise from bad feeding, and improper management in dressing and the use of exercise.

The cure will commonly be effected by giving strengthening remedies, with calomel and squills in moderate doses, and by the gradual use of elastic bandages to the parts.

WATFORD, in *Geography*, a market-town in the hundred of Cashio, and county of Hertford, England, is 8 miles S.E. from St. Alban's, 20 miles W.S.W. from the county-town, and 14 miles N.W. from London. Previous to the Conquest, Watford formed part of Cashio, and under that appellation was given by king Offa to the abbey of St. Alban's, to which it continued attached till the time of the dissolution, when the stewardship of this and other adjacent manors was given to John, lord Ruffel. James I., in the seventh year of his reign, granted Watford to the lord chancellor Eger-ton, in whose descendants, the dukes of Bridgewater, it remained vested till about the year 1760, when it was purchased by the then earl of Essex, and is now the property of the present earl. The town consists principally of one street; the houses being ranged on the sides of the high road, and extending in a north-westerly direction rather more than a mile. The buildings are chiefly of brick, and many of them very respectable. The police is under the direction of the resident and neighbouring magistrates. A market, which is now held on Tuesdays, was granted to the abbots of St. Alban's for Watford by Henry I.; and Edward IV. gave them liberty to hold two annual fairs, which are now increased to four. The market-house is a long building, rough-cast above, and supported on wooden pillars beneath. Corn is sold here in very large quantities; and the number of cattle, sheep, calves, and hogs, is proportionable. Employment for the labouring classes is chiefly derived from agriculture; but an additional source is furnished by the throwing of silk, three silk mills having been established in or near the town. The parish of Watford comprehends, with the town, the hamlets of Cashio, Levesdon, and Oxhey. In the population return in the year 1811, the number of inhabitants was stated to be 3976, occupying 766 houses. The church, a very spacious edifice, consists of a nave, three aisles, and a chancel; with a massive embattled tower at the west end, about 80 feet high. The church contains several fine monuments, among which are two by Nicholas Stone. At the south side of the church-yard is a free-school, founded and endowed in the year 1704, by Mrs. Elizabeth Fuller, for the education and clothing of forty boys and twenty girls: the government is vested in nine trustees, chosen out of the principal inhabitants of the town. Here are also eight alms-houses, for the maintenance of so many poor widows.

About one mile north-west of the town is *Cashbury*, the seat of the earl of Essex. The mansion is a spacious edifice, situated in an extensive and well-wooded park, through which flows the river Gade; and to which is the line of the Grand Junction Canal. The house was originally begun in the time of Henry VIII. by Richard Morison, esq., and completed in the style of that age by his son, sir Charles Morison. It has since been greatly altered and improved, particularly under the direction of the present noble owner, and contains a number of elegant apartments, together with a kind of cloister, the windows of which have been recently ornamented with painted glass, executed in a very superior style. In its general appearance, the whole mansion, with its offices, has the character of a monastic dwelling. The rooms are adorned with numerous portraits, and other pictures of the first degree of merit. The park is between three and four miles in circumference, and affords rich scenery and noble timber; the pleasure-grounds and gardens are extensive, and have lately undergone some judicious alterations. A particular description of this splendid seat, by Mr. Britton, is contained in Havell's "Views of Gentlemen's Seats," &c. which also contains a print of it.—Salmon's History of Hertfordshire, fol. 1728. Beauties of England and Wales, vol. vii. Hertfordshire, by E. W. Brayley, 1808.

WATH, in *Rural Economy*, a term often used provincially to signify a ford.

WATHULT, in *Geography*, a town of Sweden, in the province of Smaland; 47 miles W.N.W. of Wexio.

WATKIN'S POINT, a cape on the S.W. coast of Maryland, in the Chesapeake. N. lat. 37° 59'. W. long. 76°.

WATLING'S ISLAND, one of the Bahama islands, about 18 miles long, and 4 broad. N. lat. 23° 50'. W. long. 74° 16'.

WATLING-Street, in *Roman Antiquity*. See WAY.

WATLINGTON, in *Geography*, a small market-town in the hundred of Pirton, and county of Oxford, England, is situated between the two high roads leading from London to Oxford, about half a mile N. by W. from the Ike-neild-street, at the distance of 5 miles S. from Tetworth, 15 miles S.E. from Oxford, and 46 miles W. by N. from London. The streets are narrow, and the houses, with a few exceptions, mean and ill built. There is no staple manufacture of any consequence: the making of lace, however, prevails to some extent, and forms the chief employment of the labouring females. A school has been formed expressly for the purpose of teaching this art, and is usually attended by from forty to fifty pupils. The town is watered on the south side by a brook, rising in the vicinity, which now works, within two miles from its source, four corn-mills. A weekly market is held on Saturdays, which was originally granted to Roger Bigod, earl of Norfolk, in the reign of Richard I. But this market is thinly attended; and the business of the day is invariably conducted in the parlours of the principal inn. Here are likewise two annual fairs. In the centre of the town is the market-house, a substantial building, erected by Thomas Stonor, esq. in the year 1664: he also founded and endowed a grammar-school for ten boys; according to the will of the donor, the master was to be a graduate of one of the universities; but imperative circumstances have caused this article to be dispensed with: four boys have been added to the original number, and the whole are taught in a commodious room above the market-house, in which are likewise held the courts leet and baron of the manor. The magistrates hold a petty sessions once in a fortnight during the winter, but in summer not so often. According to the population return of the year 1811, this town

then contained 239 houses, the number of inhabitants being 1150, which was a decrease of 156, since the enumeration of the year 1801. The church is a respectable ancient building, situate N.W. of the town: in the chancel are several neat monuments, and a handsome burial-place of the Horne family. Lands and tenements have been left by will for the repairs of the church, without any parish-rate for that purpose; and there have also been considerable sums bequeathed for the use of the poor. Previous to the Reformation, the abbot and canons of Olney were patrons, to whom the church was appropriated in 1263, by the bishop of Lincoln. In this parish was anciently a chapel, founded by the lord of the manor of Watcomb; but on a complaint made by the abbot and canons of Olney, pope Urban III. dissolved it: no traces can now be discovered of the site occupied by this structure. Wesleyan Methodists and Baptists have each a place of worship in the town; but the number of these societies is comparatively small. The Methodists were established here during the life of John Wesley, who occasionally preached in the open street: a substantial meeting-house has lately been erected, but not more than thirty persons are in the habit of attending. The Baptists are scarcely so numerous; and their meetings are held in a very humble building. The manor of Watlington was given by Henry III. in 1231, to his brother Richard, earl of Cornwall. By Edward II. it was granted to Piers Gaveston. On his disgrace it reverted to the crown, and was given by Edward III. to sir Nicholas De la Becke, who obtained permission, in 1338, to build a spacious castle, some traces of which were discernible within the last century. The building stood on a slightly elevated spot to the south-east of the church, and it may yet be perceived that the structure was encompassed by a moat. King Charles I. granted the manor, in 1628, to four citizens of London, who sold it in the following year. Soon after this period it became so divided and parcelled out, that in the year 1664 there were about fifty persons participating in the manorial rights; and previous to the enclosure of the parish, which took place in 1809, the shares of the manor were sixty-four in number.

On *Britwell-hill*, about a quarter of a mile east of the Ike-neild-street, some remains of trenches point out the site of an ancient encampment.

Within half a mile from Watlington is one of the most complete agricultural establishments to be found in the county. The whole of the very extensive farm-yard is encompassed by buildings covered with slate, and presents the spectacle of a new and handsome village. This noble range was erected under the immediate inspection of William Hayward, esq., and was completed in the space of one year. His primary object appears to have been to produce utility on the simplest and most scientific plan.

About a mile to the north of Watlington is Pirton, an inconsiderable village, though it gives name to the hundred. Near Pirton is *Shirbourn-Castle*, the seat of the earl of Macclesfield. A castellated edifice was first erected on this spot in the fourteenth century by sir Warner de l'Isle. The castle and manor were purchased at the beginning of the eighteenth century by Thomas, earl of Macclesfield. The building forms an oblong square, and is encompassed by a broad and deep moat, over which are three draw-bridges; the chief entrance is guarded by a portcullis: at each angle of the edifice is a circular tower. The interior is disposed in a style of modern elegance and comfort that contains no allusion to the external character of the structure, except in one long room fitted up as an armoury, and containing coats of mail, shields, tilting-spears, and offensive arms of a modern as well as ancient date. A park of about sixty acres is attached

attached to the mansion.—Beauties of England and Wales, vol. xii. Oxfordshire. By J. N. Brewer, 1813.

WATO, a town of Sweden, on an island in the Baltic, near the coast of the province of Upland; 10 miles E.N.E. of Nortelge. N. lat. 59° 54'. E. long. 18° 43'.

WATOLMA, a town of Sweden, in the province of Upland; 10 miles N. of Upfal.

WATRAP, a town of Hindooftan, in Madura; 33 miles S.W. of Madura.

WATSCH, or VATSCHE, a town of the dutchy of Car-niola; 16 miles S.E. of Stein.

WATSNESS, a cape on the west coast of the island of Shetland. N. lat. 60° 19'. W. long. 2° 6'.

WATSON, ROBERT, D.D., in *Biography*, a Scottish historian, was born at St. Andrew's about the year 1730, commenced his course of education for the ministry at the school and university of St. Andrew's, and with singular assiduity prosecuted his studies at the university of Glasgow, and also in that of Edinburgh. He paid particular attention to grammar and eloquence, and with the advice of lord Kaimes, delivered a course of lectures on these subjects, which gained the approbation of Mr. Hume, and other men of genius and learning. Having failed in his endeavours to supply a vacancy in one of the churches of St. Andrew's, he was soon after made professor of logic, and by a patent from the crown, professor of rhetoric and belles lettres. In his lectures on logic and metaphysics, he deviated from the old plan of syllogisms, modes, and figures, and introduced substantial improvement by furnishing his pupils with an analysis of the powers of the mind, and by leading them to investigate the various kinds of evidence, of knowledge or truth. His history of Philip II. advanced his reputation during the period of his life; and it was farther enhanced by his history of Philip III., which was published after his death; of which latter he only wrote the first four books, the other two being supplied by Dr. William Thomson, the editor, at the desire of the guardians of his children. He succeeded Tulideph as principal of the university by the interest of the earl of Kinnoul; but his death, in 1780, soon deprived him of this honour. By his wife, who was daughter of Mr. Shaw, professor of divinity in St. Mary's college, St. Andrew's, he had five daughters, who survived him. Gen. Biog.

WATSON, RICHARD, an English prelate, eminently distinguished by his talents, acquirements, and character, was born at Haverham, in Westmoreland, in August 1737. He was the descendant of an ancient family, deriving its remote origin from Scotland, and occupying, for several generations, a small estate at Hardendale, near Shap, where his father was born in the year 1672. In 1698 his father was appointed head master of Haverham-school, which he conducted with great reputation for nearly forty years. Among other pupils who enjoyed the benefit of his instruction, we may mention Ephraim Chambers, the well-known author of the Dictionary of Arts and Sciences (see his article), Mr. Preston, afterwards bishop of Ferns, in Ireland, and the subject of this memoir. To this school belonged two exhibitions, (now of 50*l.* a year each,) one to Trinity college, in Cambridge, and the other to Queen's college, Oxford; the former of which was enjoyed by Mr. Preston, and afterwards by his school-fellow, Mr. Watson. In the year 1788, these two scholars, being then bishops, testified their regard for the place of their education by repairing the school-house, and by affixing to it a Latin inscription, expressing their respect for the memory of its pious founder, and of Mr. Watson's father. To his mother also Mr. Watson pays a tribute of grateful and affectionate

remembrance, describing her as a charitable and good woman, to whom he was indebted for imbuing his young mind with principles of religion, which never forsook him; and observing more generally, that "the care of the mother precedes that of the school-master, and may stamp upon the *rafa tabula* of the infant mind, characters of virtue and religion which no time can efface." Soon after the death of his father, in November 1753, Mr. Watson was sent to the University, and admitted a sizar of Trinity college, in Cambridge, on the 3d of November, 1754. Apprized that his patrimony, which was 300*l.*, would be barely sufficient to defray the charges of his education, and having no expectations from any of his relations, he determined to fabricate his own fortune, and applied with assiduity and ardour to his academic studies. Before he had been six months at college, a circumstance occurred which indicated his talents for metaphysical disquisition, and which contributed in no small degree to his reputation in this department of science. As he attended the college-lectures, which were then delivered to the under-graduates in the hall, immediately after morning-prayers, during term-time, he was asked by Mr. Brocket, the head lecturer, whether Clarke had demonstrated the absurdity of an infinite succession of changeable and dependent beings? to which question he replied *non*; and being asked his reasons for so thinking, he stammered out, as he says, in barbarous Latin, "that Clarke had enquired into the *origin* of a series, which, being from the supposition *eternal*, could have no origin; and into the *first* term of a series, which, being from the supposition *infinite*, could have no first." This circumstance was recollected four years afterwards, when he took his bachelor's degree, and laid the foundation of his acquaintance with Dr. Law, then master of Peterhouse, and reckoned one of the best metaphysicians of his time; from which he derived, as he acknowledges, much knowledge and liberality of sentiment in theology. Not satisfied with his rank of sizar, he aspired to a scholarship, and succeeded in obtaining it, on the 2d of May, 1757, a year before the usual time. Thus advanced in rank, his expences increased, but they were more than counterbalanced by the advantage attending it. Dr. Smith, who was then master of the college, took occasion to nominate him to a particular scholarship (lady Jermy'n's); and at the same time recommended Saunderfon's Fluxions, just published, and some other mathematical books, to his perusal; thus, as he says, "giving a spur to my industry, and wings to my ambition." At this time he had resided in college two years and seven months, without leaving it for a single day; and during this period, he had acquired some knowledge of Hebrew, improved himself greatly in Greek and Latin, made considerable proficiency in mathematics and natural philosophy, and studied with much attention Locke's Works, King's book on the Origin of Evil, Puffendorf's Treatise "De Officio Hominis et Civis," and some other books on similar subjects. Conceiving himself entitled to some degree of relaxation, he set out, in May, 1757, on a visit to his elder and only brother at Kendal, who was the first curate of a new chapel erected there, and to the building of which he had liberally contributed. This brother lived freely, spent his fortune, injured his constitution, and died when the subject of our memoir was about the age of 33. With the affection of a brother and singular liberality, he paid his debts, to the amount of almost his whole property. In the beginning of September he returned to college, with a purpose to make his alma mater the mother of his fortunes. He was then only a "junior sopher;" but such was his reputation, that he was solicited to become private tutor to Mr. Luther and Dr. Strachey. From the

time in which he undertook this charge he was employed for thirty years, and as long as his health lasted, in instructing others, without much instructing himself, as he suggests, and in presiding at disputations in philosophy or theology, from which, after a certain time, he derived little intellectual improvement. Addicted, whilst an under-graduate, to associate with those whom collegians call the best company; such as idle fellow-commoners, and other persons of fortune: he soon perceived that he was pursuing a mistaken course: and this conviction was more sensibly felt, when he often saw, on his return home at one or two in the morning, from some of his evening festivities, a light in the chamber of a fellow-student of the same standing with himself. His jealousy was thus excited, and the succeeding day was always devoted to hard study; nor would he allow himself the leisure for dinner. In his solitary walks he prosecuted the study of mathematics and philosophy without book, or pen and paper; and went through tedious and intricate demonstrations by the mere exercise of his mental powers. These walks were so frequent, that among those who did not know how he was employed, he incurred the charge of being a lounge; but the sequel of his history sufficiently proves the injustice of the charge.

Whilst abstract studies occupied his chief attention, he did not neglect other pursuits. Every day he imposed upon himself the task of composing a theme in Latin or English. Among the first of his compositions of this kind, the subject of that written in English was "Let tribunes be granted to the Roman people," and that of the Latin was "Sociis Italicis datus Civitas:" the subjects of both were suggested to him by a perusal of Vertot's "Roman Revolutions;" and to his account of this incident he adds, "Were books of such kind put into the hands of kings during their boyhood, and Tory-trash at no age recommended to them, kings in their manhood would scorn to aim at arbitrary power through corrupted parliaments." He also introduces this reflection on the choice of his subjects: "They shew that a long commerce in the public world has only tended to confirm that political bent of my mind in favour of civil liberty, which was formed in it before I knew of what selfish and low-minded materials the public world was made." In the course of Mr. W.'s classical reading, to which he devoted the afternoon, whilst the morning was occupied by mathematics, he informs us, that Demosthenes was the orator, Tacitus the historian, and Persius the satirist, whom he most admired. At an early period of his life, Mr. W. inclined to the opinion which has in later times been more prevalent, that the soul is not a distinct substance from the body; though he professes not to have troubled himself much with perplexing disquisitions concerning liberty and necessity, matter and spirit; shewing, however, on all occasions, his faith in Christianity, as founded on testimony, and more especially on the testimony concerning the resurrection of its divine founder; and his belief of a future state of retribution and immortality. His speculations on matter and spirit are not likely, in our judgment, to illumine the darkness, and to resolve the difficulties that involve this subject. As to the story, recorded in the French Encyclopædia (art. *Mort*), of a man who came to life after having been six weeks under water, we cannot help considering it as fabulous; but whether it be true or false, it appears to us to afford little satisfaction with regard to the question in dispute. Nor does his reasoning about the essential properties of extension, solidity, mobility, divisibility, and inactivity, as common properties, belonging equally to a table, tree, oyster, and man, and the addition of life to the matter of the tree, of life and perceptivity to that of the oyster, and to that of

the man, life, perceptivity, and thought, seem to have given very great satisfaction to himself. "Whether life can exist without perceptivity," he says, "or perceptivity without thought, are subtle questions, not admitting perhaps, in our present state, a positive and clear decision either way. Physical and metaphysical difficulties present themselves on every subject, and ultimately baffle all our attempts to penetrate the darkness in which the divine mind envelopes his operations of nature and grace."

In January 1759, Mr. W. took his degree of bachelor of arts. In the first year of his being moderator, he introduced an alteration in the mode of obtaining this degree, which has been continued ever since. "At the time of taking it, the young men are examined in classes, and the classes are now formed according to the abilities shewn by individuals in the schools. By this arrangement, persons of nearly equal merits are examined in the presence of each other, and flagrant acts of partiality cannot take place. Before this alteration was made, they were examined in classes, but the classes consisted of members of the same college, and the best and the worst were often examined together." In the first year of his being moderator, Mr. Paley, afterwards so well known, and a Mr. Frere of Norfolk, were examined together; and Mr. Paley, being Mr. Frere's superior, was made senior wrangler, though it was reported that the grandfather of Mr. Frere had proposed to give 1000*l.* if he were admitted to this honour. This gentleman afterwards candidly acknowledged that he deserved only the second place; and this declaration was obviously the result of their having been examined together. One of the questions proposed by Mr. Paley for his act was "Æternitas pœnarum contradicit Divinis attributis." This question, though accepted by Mr. W., occasioned an alarm; but in order to allay all disquieting apprehensions, Mr. P. was allowed to put in *non* before *contradicit*, and the alarm subsided. This, however, says Mr. W., is a subject of great difficulty. "It is observed, on all hands, that the happiness of the righteous will be, strictly speaking, everlasting; and I cannot see the justness of that criticism which would interpret the same word in the same verse in a different sense. (Matt. xxv. 46.) On the other hand, reason is shocked at the idea of God being considered as a relentless tyrant, inflicting everlasting punishment which answers no benevolent end. But how is it proved that the everlasting punishment of the wicked may not answer a benevolent end, may not be the means of keeping the righteous in everlasting holiness and obedience? How is it proved, that it may not answer, in some other way unknown to us, a benevolent end in promoting God's moral government of the *Universe*?"

In October 1760, Mr. W. was elected a fellow of Trinity college, although by that appointment he was put over two of his seniors of the same year; and in the following November became assistant tutor to Mr. Backhouse. Soon after this he declined accepting the curacy of Clermont; and he also relinquished his design of going out as chaplain to the factory at Bencoolen. "You are far too good," said the master of the college to him, "to die of drinking punch in the torrid zone." Afterwards he reflected with gratitude and self-complacency on his disappointment of an opportunity of becoming an Asiatic plunderer. "I might not," he says, "have been able to resist the temptation of wealth and power, to which so many of my countrymen have yielded in India."

At the commencement of 1762 he took his degree of M.A., and in the following October was made moderator for Trinity college. In his "Memoirs," he recites the questions which were at that time the subjects of scholastic exercises,

ercises, and from their nature and variety he justly infers the importance of these exercises.

In February 1764 an occasion was afforded him of manifesting his friendly attachment to Mr. Luther, one of the members for Essex, who had been formerly his pupil, and his disinterested anxiety for his happiness. Having heard that he had separated from his wife, and was hastily gone abroad, he immediately prepared to seek him, and to impart to him, if possible, some consolation. Although he had no money, and could not speak a word of French, he determined on his journey; and having borrowed 50*l.*, and provided a French and English Dictionary, he posted to Dover, and hastened to Paris, where he found his disconsolate friend. After twelve hours stay at Paris, he returned to England; and having crossed the channel four times, and travelled 1200 miles in very bad weather within a fortnight, he brought his friend back to his country and his family. Of Mr. Luther, he says that "he was a thorough honest man, and one of the friends I ever loved with the greatest affection."

In November 1764, he was unanimously elected by the senate to succeed Dr. Hadley, as professor of chemistry; and though at this time he knew nothing of chemistry, he procured an operator from Paris, and immured himself in his laboratory, so that in 14 months from his election he read a course of chemical lectures to a very full audience, and another in November 1766. For the fourth time he was made moderator in October 1765, and in 1766 made his last speech in Latin to the senate. Besides other improvements in the university education, which he had proposed on former occasions, he now recommended the institution of public annual examinations, in prescribed books, of all the orders of students. In 1774 this subject was revived and enforced by Mr. Jebb. The design was unequivocally approved by the chancellor of the university, the duke of Grafton. After a long discussion of the subject, the regulations drawn up by the syndics were proposed to the senate, and were rejected by the "Non Regent House," 47 against 43. In 1764 application was made for a stipend to the professor of chemistry; and after considerable delay, 100*l.* a year was obtained: and this grant paved the way for similar stipends to the professors of anatomy, botany, and common law. In October 1767, Mr. Watson succeeded Mr. Backhouse as head tutor in Trinity college, and, for the short period during which he retained the office, discharged its duties with conscientious diligence. "In this," he says, "and the two following years, I read chemical lectures to very crowded audiences, in the month of November. I now look back with a kind of terror at the application I used in the younger part of my life. For months and years together, I frequently read three public lectures in Trinity college, beginning at 8 o'clock in the morning; spent four or five hours with private pupils, and five or six more in my laboratory, every day, besides the incidental business of presiding in the sops schools."

In 1768 he composed and printed his "Institutiones Metallurgicæ," and about the same time presented to the Royal Society a paper on the solution of salts, and was elected a fellow of that society. In the following year he published his Assize Sermon, which he dedicated to Mr. Luther. Upon the vacancy in the office of regius professor of divinity, occasioned in October 1771 by the death of Dr. Rutherford, Mr. Watson proposed to become a candidate; but he was then neither bachelor nor doctor in divinity; and without being one of these, he could not be admitted as a candidate. Prompt, however, in the execution of all his measures, though he had only seven days for the

accomplishment of his object, he obtained the king's mandate for a doctor's degree, and was created a doctor on the day previous to that appointed for an examination of the candidates. The subjects on which he was to write were, the reconciliation of the genealogies in Matthew and Luke, and the interpretation of the passage, "What shall they do that are baptized for the dead?" 1 Cor. xv. 29. He was also appointed to read a Latin dissertation on Gen. x. 32.

At length he was unanimously elected, having, as he says, by hard and incessant labour for 17 years, attained, at the age of 34, the first office for honour in the university, and, exclusive of the mastership of Trinity college, he made it the first for profit; having advanced it from 330*l.* a year to at least 1000*l.* Having been promoted to this honourable and important office, he devoted himself, with his accustomed resolution and perseverance, to the study of divinity; making the Bible the object of his investigation, and feeling no concern about the opinions of councils, fathers, churches, bishops, or other men, as little inspired as himself. Although he was called by the master of Peterhouse, *αυτοδιδάκτος*, the self-taught divine; and though the professor of divinity had been nicknamed "Mallens Hæreticorum," he professes that his mind was wholly unbiassed; without prejudice against or predilection for the church of England; and actuated only by a sincere regard for the church of Christ, and an insuperable objection to every degree of dogmatical intolerance. "I never troubled myself," thus he proceeds, "with answering any arguments which the opponents in the divinity schools brought against the articles of the church, nor ever admitted their authority in decision of a difficulty. But I used, on such occasions, to say to them, holding the New Testament in my hand, 'En sacrum codicem! Here is the fountain of truth; why do you follow the streams derived from it by the sophistry, or polluted by the passions of men? If you can bring proofs against any thing delivered in this book, I shall think it my duty to reply to you: articles of churches are not of divine authority; have done with them; for they may be true, they may be false; and appeal to the book itself.' This mode of disputing gained me no credit with the hierarchy; but I thought it an honest one, and it produced a liberal spirit in the university."

About the close of the year 1771 our author printed an Essay on the subject of chemistry, which was dispersed among some few friends; but it was unjustly charged by the authors of the "Journal Encyclopedique," with favouring the "Système de la Nature." The author remonstrated, and the periodical journalists made an apology. In the following year Dr. Watson published two letters to the members of the house of commons, under the feigned name of a Christian Whig, the second of which was inscribed to Sir George Savile. In 1773, upon maturely weighing the question concerning the abstract right which a national church may claim of requiring subscription to human articles of faith from its public ministers, he published "A brief State of the Principles of Church Authority," which he delivered as a charge to the clergy of his diocese, in June 1813. In this tract it is maintained, that every church has a right of explaining to its ministers what doctrines it holds; and of permitting none to minister in it, who do not profess the same belief with itself. With respect to another question, *viz.* whether the majority of the members of any civil community have a right to compel all the members of it to pay towards the maintenance of a set of teachers appointed by the majority to preach a particular system of doctrines, this may admit a serious discussion. Our author once thought the majority had this right in *all* cases, and he afterwards apprehended that they have it in *many*. But a case may happen,

happen, in which the established religion of a country may be the religion of a minority of the people, that minority at the same time possessing a majority of the property, out of which the ministers of the establishment are paid; and if this should occur, our author seems to be undecided in his judgment. His sentiments as to the expediency of requiring from the ministers of the established church a subscription to the present articles of religion, or to any human confession of faith, further than a declaration of belief in the scriptures, as containing a revelation of the will of God, may be collected from his two pamphlets, subscribed "A Christian Whig," and "A Consistent Protestant."

In adverting to these tracts, our author reflects with satisfaction on the coincidence of his sentiments, on many points civil and religious, with those of bishop Hoadly, though he has been sarcastically and injuriously called "A republican bishop."

On the 21st of December 1773, Dr. Watson married the eldest daughter of Edward Wilson, esq. of Dallum Tower, in Westmoreland; and the connection was a source of uninterrupted satisfaction and felicity. Having obtained, by the interest of the duke of Grafton with the bishop of St. Asaph, a sinecure in Wales, he exchanged it, by the same interest, on his return to Cambridge, for a prebend of Ely; and this favour was granted, though the duke and Dr. Watson held different political opinions. They afterwards differed also in their religious sentiments; the duke having avowed himself an Unitarian. Referring to him under this denomination, Dr. Watson, with laudable liberality, declares, "that he is happy in seeing a person of his rank professing with intelligence and sincerity Christian principles. If any one thinks that an Unitarian is not a Christian, I plainly say, without being myself an Unitarian, that I think otherwise."

Dr. Watson's political principles are well known. From his earliest youth to his dying day he was a Whig, in that sense of the term which is well understood, and need not here be explained. In 1776 it came to his turn to preach the restoration and accession sermons before the university; and they were both printed. The first was entitled "The Principles of the Revolution vindicated." Although it was written with great caution, a report was circulated in London that it was treasonable; but when Mr. Dunning (afterwards lord Ashburton) was asked what he thought of it, he replied, "that it contained such treason as ought to be preached once a month at St. James's." However, it gave great offence to the court, and, in Dr. Watson's opinion, continued to be an obstacle to his preferment. The author was much abused, in consequence of the publication of this sermon, by ministerial writers, as a man of republican principles; but by Mr. Fox, and others of his class, it was very highly commended.

In the same year, 1776, Dr. Watson published his "Apology for Christianity," in reply to Mr. Gibbon's obnoxious chapters in his "History of the Decline and Fall of the Roman Empire." His treatment of the historian was liberal and conciliatory, and was acknowledged with great courtesy and respect. In February 1780, Dr. Watson preached, at the request of the vice-chancellor, the fast sermon before the university, which became very popular, and was widely circulated. In May of this year he published a charge to the clergy of the archdeanery of Ely, at his first visitation; the primary object of which charge was to recommend an establishment at Cambridge, for the express purpose of translating and publishing Oriental MSS., wherever found. Dr. Keene, bishop of Ely, expressed his approbation of this charge; but as he reflected on the

author's politics, he retorts it by observing in a letter to his lordship, "My politics may hurt my interest, but they will not hurt my honour. They are the politics of Locke, Somers, and Hooker; and in the reign of George II., they were the politics of this university." In February 1781, our author was presented by the duke of Rutland with the rectory of Knaploft, in Leicestershire; and as he was just then printing the first two volumes of Chemical Essays, he availed himself of this opportunity of dedicating them to his grace. In 1782, Soame Jenyns published his Disquisitions on various subjects, the seventh of which advanced principles very opposite to those which were contained in the "Principles of the Revolution vindicated," with occasional glances at that sermon. Although our author was scarcely recovered from a dangerous illness, he drew up, in the course of a few hours, "An Answer to the Disquisitions, &c." Upon a change of ministry, lord Shelburne was induced to confer the bishopric of Landaff on Dr. Watson; and on the 26th of July 1782, he kissed hands on his promotion. But he was not very much gratified by this advancement; because lord Shelburne had expressed to the duke of Grafton his expectation that he would occasionally write a pamphlet for their administration. The duke, however, did the new prelate the justice to assure his lordship, that he had totally mistaken the character of the bishop; for though he might write as an abstract question, concerning government, or the principles of legislation, it would not be with a view of assisting any administration. "I had written," says the independent and high-spirited bishop, "in support of the principles of the revolution, because I thought those principles useful to the state, and I saw them vilified and neglected. I had taken part in their petitions against the influence of the crown, because I thought that influence would destroy the constitution, and I saw that it was increasing. I had opposed the supporters of the American war, because I thought that war not only to be inexpedient, but unjust. But all this was done from my own sense of things, and without the least view of pleasing any party: I did, however, happen to please a party, and they made me a bishop. I have hitherto followed, and shall continue to follow, my own judgment in all public transactions: all parties now understand this, and it is probable that I may continue to be bishop of Landaff as long as I live. Be it so. Wealth and power are but secondary objects of pursuit to a thinking man, especially to a thinking Christian." Lord Shelburne seems to have courted an intimate acquaintance with the bishop; alleging that he had Dunning to assist him in law points, and Barry in army concerns, and expressing his wish to consult him in church matters. The bishop availed himself of this overture, and proposed to the minister a plan by which service might be done to religion and to the established church. Being invited to dine with his lordship, he put into his hand a paper, containing the following scheme of reform, comprehending the doctrine, the jurisdiction, and the revenue of the church of England. The two following hints on the subject of the revenue he submitted to the consideration of his lordship:—"First, a bill to render the bishoprics more equal to each other, both with respect to income and patronage; by annexing, as the richer bishoprics became vacant, a part of their revenues, and a part of their patronage, to the poorer. By a bill of this kind, the bishops would be freed from the necessity of holding ecclesiastical preferments *in commendam*; a practice which bears hard on the rights of the inferior clergy. Another probable consequence of such a bill would be, a longer residence of the bishops in their several dioceses; from which the best consequences

sequences both to religion, the morality of the people, and to the true credit of the church, might be expected: for the two great inducements to wish for translations, and consequently to reside in London, namely, superiority of income, and excellency of patronage, would in a great measure be removed. Second, a bill for appropriating, as they become vacant, one half, or a third part, of the income of every deanery, prebend, or curacy, of the churches of Westminster, Windsor, Canterbury, Christchurch, Worcester, Durham, Ely, Norwich, &c. to the same purposes, *mutatis mutandis*, as the first fruits and tenths were appropriated by queen Anne. By a bill of this kind, a decent provision would be made for the inferior clergy, in a third or fourth part of the time which queen Anne's bounty alone will require to effect it. A decent provision being once made for every officiating minister in the church, *the residence of the clergy in their cures might more reasonably be required than it can be at present, and the licence of holding more livings than one be restricted.*" Lord Shelburne wished to be informed if nothing could be gotten from the church to relieve the burdens of the state; to which the bishop replied, that the whole revenue of the church would not yield, if it were equally divided, which could not be thought of, above 150*l.* a year to each clergyman, which could not be thought too ample; and in a political view it would be highly inexpedient, unless government would be contented to have a beggarly and illiterate clergy, which no wise minister would ever wish to see. In prosecution of the same plan, the bishop sent a letter to the archbishop of Canterbury, and a copy to lord Shelburne, the duke of Grafton, the duke of Rutland, and lord John Cavendish respectively. The minister discouraged the business, and earnestly dissuaded the bishop from any immediate publication of it. Upon the resignation of lord Shelburne, who, by an exercise of prerogative, had been nominated by the king without the recommendation of the cabinet, the coalition ministry, formed of lord North, and others who had for many years reprobated his political principles, came into power. This circumstance of the coalition roused our prelate's indignation, and led him to entertain a very unfavourable opinion of the disinterestedness and integrity of those to whom he had been invariably attached. Although the badness of the peace, and the supposed danger of trusting power in the hands of lord Shelburne, were the ostensible reasons for this coalition, personal dislike of him, and a desire to be in power themselves, were, in the bishop's judgment, the real ones. This dissension of the Whigs, he says, did more injury to the constitution than all the violent attacks on the liberty of the subject, which were subsequently made during Mr. Pitt's administration. "This apostacy from principle in the coalition ministry ruined," as he conceived, "the confidence of the country, and left it without hope of soon seeing another respectable opposition on constitutional grounds; but it stamped on the hearts of millions an impression which will never be effaced, that *patriotism is a scandalous game played by public men for private ends, and frequently little better than a selfish struggle for power.*"—"It is," he adds, "a principle with all parties to require from their adherents an implicit approbation of all their measures: my spirit was ever too high to submit to such a disgraceful load of political connection."—"To forget all benefices, and to conceal the remembrance of all injuries, are maxims by which political men lose their honour, but make their fortunes."

Our prelate's letter to the archbishop of Canterbury was published in the interval between lord Shelburne's resignation and the appointment of the duke of Portland to the head of the treasury; but though a copy of it was sent to

each bishop, none thought proper to acknowledge it except Dr. Porteus, then bishop of Chester. Soon after the failure of Mr. Fox's East India bill, to which Dr. Watson was adverse, Mr. Pitt was appointed first lord of the treasury; and though he had continued in office for several weeks previously to the dissolution of parliament, March 25th, 1784, in direct opposition to the majority of the house of commons, which in the judgment of our prelate established a dangerous precedent, yet deference to the sense of the nation declared by numberless addresses to the king against the coalition ministry, induced him to acquiesce. In July of this year he wrote a letter to Mr. Pitt, recommending an union of Britain and Ireland on an equal and liberal footing; but it was not accomplished till sixteen years after this period, and not, as the bishop observes, "in the liberal way it ought to have been done." Enlarged and liberal as were his sentiments of toleration, he nevertheless regarded the church of Rome as a persecuting church; and he thought it was more necessary to guard against the danger to be apprehended by Protestants in a country where popery is simply tolerated than where it is the established religion. On another occasion he expresses sentiments which must lead the friends of Catholic emancipation to conclude, that he was not favourable to this object. "The persecuting spirit of the Roman church remains in the hearts of the generality of its members," he says, "and whilst it does remain, popery must be watched, intimidated, and restrained." In a letter to Mr. Wakefield written in 1784, he avows his belief of the pre-existence of Christ as the doctrine of the New Testament; but at the same time he is far from concurring with those who brand the supporters of it as enemies to the Christian system. In the same year he addressed a letter to Mr. Wyvill, expressing his warmest wishes for parliamentary reform, which Mr. Pitt seemed at the commencement of his administration inclined to promote. In 1785 he published his "Collection of Theological Tracts," in six volumes, intended for the benefit of young persons, who could not afford to purchase many books in divinity; the design was laudable, and was generally approved; though, he says, the bishops were not pleased with his having printed some tracts originally written by Dissenters. In January 1786 he lost his friend Mr. Luther, with whom he had lived on terms of the most affectionate intercourse for thirty years; and in mentioning this circumstance he gratefully acknowledges his generous bequest, which enabled him to preserve his independence, and to provide for his family. To his Sussex estate, from the sale of which he derived 20,500*l.*, this generous testator added the entail of his estate in Essex. Having, in the year 1782, published a third volume of his Chemical Essays, he presented to the public a fourth volume in 1786. About this time application was made to him by government for advice relating to the improvement of gun-powder; and he suggested a plan of making charcoal by distilling the wood in close vessels, which was carried into execution at Hythe in 1787, and which produced a considerable saving in the manufacture of this article.

Dr. Watson, having been attacked with a disorder in 1781, which continued and rendered the discharge of his duty, as professor of divinity, very irksome to his feelings, and likely to hasten the termination of his life, intimated to Mr. Pitt his wishes for some kind of preferment that would enable him to resign his professorship; his church income, exclusive of it, being only about 1200*l.* a year. This application he very reluctantly renewed, but it produced no effect; and the consequence was a kind of remonstrance, in the tone of complaint, on the part of the bishop to the minister.

nister. About this time Mr. Pitt consulted the bishops about the repeal of the Test and Corporation Acts; and of all the bishops who were assembled for the discussion of the subject bishop Watson and bishop Shipley were the only two who voted, that they ought not to be maintained. The question was afterwards lost in the commons by a majority of 78; 178 to 100. When it was brought forward again in 1789, it was lost by a majority of 20; 122 to 102. But in 1790, the majority against it was 194; 299 to 105: the clamour of "the church is in danger" having in the mean while been widely and loudly circulated, under the sanction of some imprudent or misunderstood expressions in the publications of Dr. Hartley and Dr. Priestley. The bishop's interest with the minister was not promoted by the part which he took on this occasion, and much less by his parliamentary speech against Mr. Pitt's commercial treaty with France. Soon after this he was very much enfeebled by a dysentery; and upon his return from Bath to Cambridge in 1787, the senate appointed Dr. Kipling to be his deputy as professor, with a salary amounting in a course of time to two-thirds of the value of the professorship, when Dr. Watson first undertook it. At the ensuing commencement he delivered a kind of farewell address to the university, in which he expressed his warmest wishes for its prosperity; after having been incessantly engaged in its business for more than thirty-three years. After the commencement he took a journey to Westmoreland, with a view to the re-establishment of his health. He now determined to become an agriculturist; and his pursuits in this department, as an improver of land and planter of trees, were so favourable to his health, and upon the whole so profitable, that he says in the year 1809, "I feel much satisfaction at this moment in having, by my own exertions, wholly counteracted the effects which might otherwise have followed the neglect I have experienced from the court or from its ministers, or from both, that I sincerely pity, and cordially forgive the littleness of mind, which, in some one or other, has occasioned it." The bishop relates an incident which occurred on occasion of his attending a levee in November 1787, and which sufficiently evinced the pains that had been taken to instil wrong notions of his political principles into his majesty's mind. "I was standing," he says, "next to a Venetian nobleman; the king was conversing with him about the republic of Venice, and hastily turning to me said, 'there now, you hear what he says of a republic.' My answer was, 'Sir, I look upon a republic to be one of the worst forms of government.' The king gave me, as he thought, another blow about a republic. I answered that I could not live under a republic. His majesty still pursued the subject: I thought myself insulted and firmly said, 'Sir, I look upon the tyranny of any one man to be an intolerable evil, and upon the tyranny of a hundred to be a hundred times as bad;' thus ended the conversation."

Although Dr. Watson, as professor of divinity, had been for many years a chartered member of the society for propagating the gospel in foreign parts, he had never subscribed to it nor attended its meetings; because its missionaries were more busily employed in bringing over Dissenters to episcopacy than in converting heathens to Christianity.

In the year 1788 he published a charge which he had delivered at his visitation, entitled "An Address to Young Persons after Confirmation." Towards the close of this year and the commencement of the next, he took an active part in the business of the regency, occasioned by the king's mental derangement; and in an elaborate speech delivered in the house of lords January 22d, 1789, he discussed, with singular ability, the subject in debate between Mr. Fox, who asserted "that

the prince of Wales had a right to assume the regency," and Mr. Pitt, who had said, "that the prince of Wales had no more right to assume the regency than any other man in the kingdom had." The part he took on this occasion is said to have offended the queen; who, as he says, "distinguished by different degrees of courtesy on the one hand, and by meditated affronts on the other, those who had voted with, and those who had voted against the minister." At the drawing-room, held on the king's recovery, the bishop was received with a degree of coldness, "which would have appeared to herself ridiculous and ill-placed could she have imagined how little such a mind as mine regarded, in its honourable proceedings, the displeasure of a woman, though that woman happened to be a queen." The prince of Wales, who was witness to this conduct, paid particular attention to the bishop, invited him to dine at Carlton-house, and entered into a familiar conference with him; the bishop on the occasion "advising him to persevere in dutifully bearing with his mother's ill-humour, till time and her own good sense should disentangle her from the web which ministerial cunning had thrown around her." When the bishop, before the close of the interview, declared that he was sick of parties, and should retire from all public concerns, "No," said the prince, "and mind who it is that tells you so, you shall never retire; a man of your talents shall never be lost to the public." The bishop's reflection subjoined to this anecdote is, "I have now lived many years in retirement, and, in my 75th year, I feel no wish to live otherwise." About ten years after the publication of the tract which he had given to the young persons of his diocese, already mentioned, Mr. Ashdown of Canterbury addressed two letters to him, in which he contended that the distinction of ordinary and extraordinary operations of the Holy Spirit is not founded in scripture, and that if it were, both operations ceased with the apostolic age. In reference to this opinion, the bishop declares, "I am not ashamed to own, that I give a greater degree of assent to the doctrine of the extraordinary operation of the spirit in the age of the apostles, than I do to that of his immediate influence, either by illumination or sanctification, in succeeding ages. Notwithstanding this confession, I am not prepared to say, that the latter is an unscriptural doctrine: future investigation may clear up this point, and God, I trust, will pardon me an indecision of judgment proceeding from an inability of comprehension. If it shall ever be shewn, that the doctrine of the ordinary operation of the Holy Ghost is not a scripture doctrine, Methodism, Quakerism, and every degree of enthusiasm, will be radically extinguished in the Christian church; men, no longer believing that God does that by more means which may be done by fewer, will wholly rely for religious instruction, consequent conversion, and subsequent salvation, on his Word."

In the summer of 1789, our bishop, in pursuit of his plan for retiring from public life, laid the foundation of his house on the banks of the Winandermere; where he continued till his death. On occasion of the publication of "Hints to the New Association, recommending a Revival of the Liturgy, &c." in 1789, by the duke of Grafton, two pamphlets were in the following year published in opposition to these "Hints." The bishop made a reply to these attacks; and took a comprehensive view of the subject. Although he was dissuaded from publishing his tract, it soon appeared under the title of "Considerations on the Expediency of revising the Liturgy and Articles of the Church of England," by a Consistent Protestant. Moreover, it was proposed, in conversation with the duke of Grafton, to commence a reform, by the introduction of a bill into the

house of lords, for expunging the Athanasian creed from the Liturgy; but on account of the French revolution, the design was postponed. In this connection, we cannot forbear mentioning what is called the Windsor anecdote. It is as follows; and given by the bishop on the authority of Dr. Heberden: "The clergyman there, on a day when the Athanasian creed was to be read, began with *Whosoever will be saved*, &c. the king, who usually responded with a loud voice, was silent; the minister repeated, in a higher tone, his *Whosoever*; the king continued silent; at length the Apostle's creed was repeated by the minister, and the king followed him throughout with a distinct and audible voice." "I certainly dislike," says the bishop, "the imposition of all creeds formed by human authority; though I do not dislike them, as useful summaries of what *their compilers believe* to be true, either in natural or revealed religion." In a letter to the duke of Grafton, dated October, 1791, he briefly states his sentiments on several subjects of importance. Amongst other observations that deserve attention, he says, "In England we want not a fundamental revolution; but we certainly want a reform both in the civil and ecclesiastical part of our constitution; men's minds, however, I think, are not yet generally prepared for admitting its necessity. A reformer of Luther's temper and talents would, in five years, persuade the people to compel the parliament to abolish tithes, to extinguish pluralities, to enforce residence, to confine episcopacy to the overseeing of dioceses, to expunge the Athanasian creed from our liturgy, to free Dissenters from test acts, and the ministers of the establishment from subscription to human articles of faith. These, and other matters respecting the church, ought to be done: I want not courage to attempt doing what I think ought to be done; and I am not held back by considerations of personal interest; but my temper is peaceable, I dislike contention, and trust that the still voice of reason will at length be heard.—As to the civil state, it cannot long continue as it is, &c. &c." In a charge delivered in 1792, the bishop touched on several subjects of importance and general interest; and among other things on the injustice and impolicy of our Test and Corporation Acts. "There seem to me," says our prelate, "but two reasons for excluding any honest man from eligibility to public office;—want of capacity to serve the office, and want of attachment to the civil constitution of the country. That the Dissenters want capacity will not be asserted; that they want attachment to the civil constitution of the country is asserted by many, but proved by none."—"The Dissenters are neither Tories nor Republicans, but friends to the principles of the revolution;" but their conduct since the revolution, and at and since the restoration, proves that they have no design to undermine the constitution of the country.

"But it may be said, that inasmuch as the Dissenters are enemies to the church establishment, and that the state is so allied to the church, that he who is unfriendly to the one must wish the subversion of both. I think this reasoning is not just; a man may certainly wish for a change in an ecclesiastical establishment, without wishing for a change in the civil constitution of a country. An Episcopalian, *e. g.* may wish to see bishops established in all Scotland, without wishing Scotland to become a republic: and he may wish that episcopacy may be established in all the American states, without wishing that monarchy may be established in any of them. The protection of life, liberty, and property, is not inseparably or exclusively connected with any particular form of church-government. The blessings of civil society depend upon the proper execution of good laws, and upon the good morals

of the people; but no one will attempt to prove, that the laws and morals of the people may not be as good in Germany, Switzerland, Scotland, under a Presbyterian, as in England or France, under an episcopal form of church-government," with much more to the same purpose.

In the year 1795 our bishop made a speech in the house of lords in favour of a motion by the duke of Bedford, "that no form of government which may prevail in France should preclude a negotiation with that country, or prevent a peace whenever it could be made consistently with the honour, interest, and security of the nation." In the following summer he published a charge, and two sermons, one of them entitled "Atheism and Infidelity refuted from Reason and Scripture;" and the other "The Christian Religion no Imposture." In 1796 he published "An Apology for the Bible," in defence of it against the scurrilous abuse of Thomas Paine. Of this tract many thousands were distributed at a low price, both in England and Scotland; and we have reason to believe produced the most beneficial effects, not only in Great Britain, but in Ireland and America. In 1798 the bishop published an address to the people of Great Britain, which was of great service in raising the spirit of the nation. In 1799 he delivered a speech, recommending and vindicating against objections a cordial union with Ireland, as an event which would enrich Ireland without impoverishing Great Britain: and that would render the empire, as to defence, the strongest in Europe. When Mr. B. Flower was brought to the bar of the house of lords for a breach of privilege in publishing something against the above-mentioned speech, the bishop, when he heard of it, declared, "that he should feel much more satisfaction in forgiving the man's malignity than in avenging it."

In 1805 the petition of the Roman Catholics of Ireland was taken into consideration by both houses of parliament, and rejected by great majorities in both. Previously to the discussion on this question, bishop Watson communicated his sentiments on the subject in a letter addressed to the duke of Grafton. As this is a question still *sub judice*, we shall here introduce the general heads of argument suggested in relation to it by the bishop. "1. The absolute justice of tolerating religious opinions, since no civil government can justly possess more power over its subjects than what individuals have consented to transfer to it when they entered into society; and no individual can give up the right of worshipping God according to his conscience, and therefore no government can justly abridge that right. 2. No civil government has any right to take cognizance of opinions either political or religious, but merely of men's actions. This principle, however, is liable to exception with respect to the public teachers of religion. 3. The established religion of every country ought to be the religion of the majority of the people; unless an exception be admitted, when the minority of the inhabitants possess a majority of the property by which the establishment is maintained; and even in that case, humanity and policy, if not strict justice, require a co-establishment of the religion of the minority. 4. Great credit ought to be given to men of probity and talents, disclaiming, in express terms, the most obnoxious principles of the church of Rome; the odium of past transactions ought not to be thrown upon those who had no concern in them. 5. Constitutionally speaking, the Catholic peers and commons have no more right to sit in parliament than a Catholic king has to sit upon the throne; and if the change of times is not yet such that a Protestant would endure the thought of a Catholic king upon the throne, it may be inquired upon what principle it is that a Protestant can endure

endure the thought of a Catholic legislator. The principle may be the little comparative influence of a Catholic legislator, and his abjuration of temporal tenets formerly professed by Catholics. 6. The progress of science has subdued the bigotry formerly too apparent not only in the church of Rome, but in all the reformed churches: and it will never be able, till a state of ignorance and barbarism recurs, to rear up its head again. There is no probability of intolerance and superstition ever more pervading Europe; and the Catholic religion will continue to derive light from the labour of learning. The learned Catholics are beginning every where to soften the asperities of their religious tenets, and to apologize for what they cannot excuse. The Irish gentry partake of the illumination of the age; and the peasantry will imitate the example of their superiors. 7. It may be said that the church of Rome has not formally renounced any of the doctrines maintained at the council of Trent, and that the court of Rome has not abandoned any of its pretensions to temporal dominion; yet Catholic, as well as Protestant, states have every where spurned these pretensions; and something very like a formal renunciation of one of the most dangerous tenets of that church took place in Russia more than twenty years ago. The empress Catharine gave permission to the Roman Catholics in her dominions merely to exercise their religion; and to have bishops of their own persuasion for the government of their church. She was present at the consecration of the first Catholic archbishop. When the ceremony had proceeded to the administration of the oath usually taken by the bishops of that church, the archbishop (that was to be) refused to repeat the clause "Hæreticos schismaticos et rebelles domino nostro papæ pro posse persequar et impugnato." On this refusal, the ceremony was ended, fresh instructions were required from Rome, and the then pope ordered the clause to be omitted; and it has been since omitted, by the authority of the pope, in the oath taken by the Irish bishops."

"My great objection," says Watson, "to the church of Rome is the uncharitable principle of the infallibility of persons out of its pale; for this principle produces a persecuting principle, and I must ever detest every species of persecution. I cannot however believe that Catholic emancipation will tend to the increase of the number of Catholics, either in Ireland or in England; on the contrary, I think the number would, by such a measure, be lessened. Nothing unites men so much as any degree of persecution. Individuals, otherwise of no consequence, either from talents or fortune, become conspicuous, and acquire a degree of weight, when connected with a party. Men claim merit from what they call their sufferings, who would have no ground for claiming it on any other species of desert."

In subsequent letters addressed to lord Grenville in 1810, and to sir John Cox Hippesley in 1812, he gives the following opinion of the *veto*: "the appointment of the Irish Catholic bishops ought to be in the king, if they are to be paid by the state; and if they are to be paid by the Catholics themselves, it ought to be in them; but exclusive of all foreign influence, recommendation, or confirmation. If they do not accede to this, or to something similar to this, they will act on a principle which I did not expect, nor can approve." In a letter to lord Hardwicke, dated April 2, 1812, he says, "I make no secret of my opinion; a cordial reception of Catholics and Dissenters into the bosom of the constitution, by the extinction of all disqualifications, is become necessary to secure the independence of the empire, and the safety of the country."

In consequence of an imputation of want of orthodoxy, partly occasioned by a sermon published by the bishop, and

entitled "A Second Defence of revealed Religion," he makes the following reflections on the ground of this charge. "What is this thing called orthodoxy, which mars the fortunes of honest men, misleads the judgment of princes, and occasionally endangers the stability of thrones? In the true meaning of the term, it is a sacred thing, to which every denomination of Christians lays an arrogant and exclusive claim, but to which no man, no assembly of men, since the apostolic age, can prove a title. It is frequently, among individuals of the same sect, nothing better than self-sufficiency of opinion, and pharisaical pride, by which each man esteems himself more righteous than his neighbours. It may, perhaps, be useful in cementing what is called the alliance between the church and state; but if such an alliance obstructs candid discussions, if it invades the right of private judgment, if it generates bigotry in churchmen, or intolerance in statesmen, it not only becomes inconsistent with the general principles of Protestantism, but it impedes the progress of the kingdom of Christ, which we all know is not of this world."

The next public occasion on which our bishop distinguished himself was on the debate which took place in the house of lords, March 23, 1807, concerning the abolition of the slave-trade. For the affirmative of this question he delivered a speech, abounding with historical information and found argument. When the administration that had been formed on the death of Mr. Pitt was dismissed, he expressed in strong terms his disapprobation of the ostensible reason alleged for its dismissal, which was the king's dislike of a measure which had been brought forward in parliament respecting the Irish Catholic officers; and the requisition on the part of his majesty of a pledge that this administration would never more bring forward the question of granting farther indulgence to the Irish Catholics. This requisition was considered by many as having a tendency dangerous to the constitution; and to Dr. W. it appeared "to be not in words, but in fact, a declaration of a *sic volo*." On occasion of the dismissal of this "half Whig, and half Tory administration," as he calls it, he communicated to lord Grenville a resolution, which he conceived to be fit to be introduced in the house of lords, whenever the subject should be brought forward, and which lord Grenville actually adopted *in toto*, as better in his opinion than any thing which had occurred either to himself or to his friends. The resolution was as follows: "Resolved, that whoever has advised, or shall in future advise, his majesty to require from his confidential servants a pledge, that they will, on any occasion, abstain from submitting to his consideration any measure of government which they, in their consciences, believe to be conducive to the public weal, is and ought by this house to be declared to be an enemy to the constitution of this country." Soon afterwards he sent to the duke of Grafton a less firm resolution, which he thought might be more acceptable to the then house of lords. Neither of these resolutions, however, was ultimately adopted; but the resolution that was actually proposed was, after a debate which lasted till 7 o'clock in the morning, negatived by a great majority. A violent alarm against Popery and of the church's danger prevailed, during which the bishop declared his opinion, "that it was both just, and in the state of Buonaparte's strength and temper towards us, highly expedient, to receive both Catholics and Dissenters into the bosom of the constitution; but that it was improper to press any innovation till the people were prepared to receive it; and that" (in his opinion) "the time was not yet come for the general adoption of such a political and equitable principle of government. Toleration was in every man's mouth; but do-

minion over the faith of other men, exclusion from privileges possessed by themselves, and a disposition to the exercise of *power without right*, were in the hearts of a great part, probably of a majority of the people of Great Britain."

In reply to a letter, in which the writer expresses a wish, that the bishop would answer Mr. Malthus's book, intitled "An Essay on Population," and in which, as he represents it, the author endeavours to establish a code of morality in opposition to the morality of the gospel, Dr. W. observes that Mr. Malthus appeared to him to be "endeavouring to shew the utility of bringing down the population of the earth to the level of the subsistence requisite for the support of man," (a proposition wanting no proof, since where there is no food, man must die,) "and that in his judgment, his time and talents would have been better employed in the investigation of the means of increasing the subsistence to the level of the population." He says, however, that after having looked into this book, he was justified in neglecting to peruse it, as it thwarted the strongest propensity of human nature, and contradicted the most express command of God, "Increase and multiply;" more especially as he was persuaded, "that the earth had not, in the course of 6000 years from the creation, ever been replenished with any thing like one half the number of inhabitants it would sustain."

The bishop might indeed well regret, as he frequently, perhaps *too frequently* does, the inattention to his merits, and claims on higher preferment than a poor Welsh bishopric, which he had long experienced, after a long course of literary labour and public service. Mr. Pitt professed himself well disposed towards him, but alleged "that a *certain person* would not hear of it." "Notwithstanding this anecdote," says the bishop, "I cannot bring myself to believe that the king was either the first projector, or the principal actor in the sorry farce of neglecting a man whom they could not dishonour, of distressing a man whom they could not despise, which has been playing at court for near 26 years." Acquitting Mr. Pitt, though he knew that no minister would be very zealous in promoting a man who professed and practised parliamentary and personal independence, from the charge of forgetting either obligations or connections in the pursuit of his ambition, he lays the blame on a more exalted personage. "As to the king's dislike of me, unless his education had made him more of a Whig, it was natural enough. My declared opposition to the increased and increasing influence of the crown had made a great impression on his majesty's mind."

Of the bill, introduced into the house of commons by the chancellor of the exchequer in 1808, for making more effectual provision for the maintenance of stipendiary curates in England and Wales, and for their residence on their cures, he expressed his disapprobation, with the reason of it, in letters addressed both to the archbishop of Canterbury and Mr. Percival. He rejoiced, however, in the grant of 100,000*l.* a year by a vote of parliament in 1809, in lieu of queen Anne's bounty; but in his charge of that year, referring to a letter previously written to lord Hawkebury on this occasion, he renews his complaint of the manner in which he had been neglected, alleging that he never had any place of residence amongst his clergy, nor a church-income sufficient to enable him to attend every year his parliamentary duty. Having, in the year 1809, and during an extensive visitation of his diocese, held a confirmation at Merthyr-Tydvil, he was hospitably accommodated at the house of the late Mr. Crawshay, a well-known iron-master, whose hospitality the writer of this article has experienced;

and before he left the diocese, Mr. C. came to Landaff to take leave of him. On this occasion, taking the bishop by the hand, he said to him, "If ever you have occasion for 5 or 10,000*l.* it shall be wholly at your service." Of course declining to avail himself of this generous offer, he nevertheless declares, "I was more delighted with this substantial proof of the disinterested approbation of an iron-master than I should have been with the possession of an archbishopric acquired by a selfish subserviency to the despotic principles of a court."

On the subject of Lancasterian schools and bible societies, he declares his opinion to be, "that certain zealous men in the established church have suffered their apprehensions for its safety to outstrip all probability of danger arising to it, from the institution of either Lancasterian schools or auxiliary bible societies. The church is in no danger from Protestant or Catholic Dissenters; but the state must ever be in danger from discontent breeding disaffection, whilst a large portion of its members is looked upon by government with a jealous and repulsive eye." On another occasion, in a letter to Mr. Wyvill, Oct. 21, 1813, he expresses sentiments of a similar kind: "the struggle for the liberty of Europe has been most nobly sustained by Great Britain, and might it not at this period be successfully terminated by our government granting emancipation to the Catholics, and a repeal of the Test and Corporation acts to the Dissenters? These concessions would be more powerful means of defence than all the confiscations of our enemy can ever be to the contrary." We cannot forbear subjoining a paragraph from Mr. Wyvill's reply: "Mr. Fox proved the sincerity of his attachment to liberty, civil and religious, by the long service of 30 years, almost wholly spent in parliament, under the frowns of power: your lordship, I believe, has given a similar proof of your attachment to that best of causes. You have endured a similar proscription from men who acted on the same unworthy motives, and the consequence has been almost the same: you have at Landaff been so long shut out from the road to the higher honours of the church. But how much higher have you risen by having obtained the undisputed dignity of virtue, benevolence, patriotism, and the true spirit of Christianity!" Well might the bishop reply to Mr. Wyvill, "I am proud of *your* honourable testimony to that political consistency of principle, which unites my name to that of Mr. Fox."

From this period the health of the bishop rapidly declined; and though his mental faculties continued unimpaired, yet bodily exercise and literary composition became irksome to him. He expired on the 4th of July, 1816, in the 79th year of his age; illustrating, as the publisher of his Memoirs says, in death the truth of his favourite rule of conduct through life: "Keep innocency, and take heed unto the thing that is right, for that shall bring a man peace at the last."

Having availed ourselves of the work now before us, we make no apology for extending this article beyond the usual limits of our biographical sketches. From the honour of an early acquaintance with the subject of this article, and from a full conviction of his uniform integrity, as well as his pre-eminent talents, we felt a peculiar interest in the perusal of the memoirs of his life. Distinguished by mental powers of a superior order, and by public services which have seldom been paralleled, we pay this tribute of respect to his memory. His character needs no delineation besides the "Anecdotes" which his own pen has furnished. In every department which he occupied, first as a student, and afterwards as a tutor and professor in the university of Cambridge, as a prelate and a member of the legislature, and in

the latter period of his life as an agriculturist, his assiduity and activity were indefatigable and persevering. To say nothing of his solicitude for the best interests of his friends and his family, the ardour of his zeal in promoting the honour and prosperity of the church and civil community to which he belonged, by those means which, according to his comprehensive and liberal views, he thought to be most conducive to this purpose, must approve itself in a high degree to those who entertained sentiments similar to his own, and it will need little apology in the candid judgment of those who most differ from him in their opinion of public men and public measures. As he always spoke and acted from the conviction of a well-informed and upright mind, and counteracted his own secular interest by the course he pursued, his sentiments claim deference, and his conduct will command respect. If it should occur to any who peruse the anecdotes now before us, that he was too ambitious of preferment, it must be recollected, that the merit of his services, both to the church and state, of which he could not be unconscious, and the elevated connections which his station in the university had led him to form, encouraged reasonable expectations of a higher rank in the church than a poor bishopric in Wales; so that he could not otherwise than feel himself neglected and disappointed. His private fortune, though his patrimony had been expended, was rendered ample by the liberality of his friend Mr. Luther, and therefore he had no just reason for complaint on this account; and yet it should be considered that he had a family, for which he wished to provide in a manner suitable to the circumstances in which his aggregate income had placed them. Anecdotes of the Life of Richard Watson, bishop of Landaff, written by himself at different intervals, and revised in 1814, &c., published by his son, Richard Watson, LL.B., prebendary of Landaff and Wells. Lond. 1817.

WATSON, in *Geography*, a town of Virginia; 35 miles S.W. of Richmond.

WATSON'S *Island*, an island in the Mergui Archipelago, of an oval form, and about 12 miles in circumference. N. lat. $9^{\circ} 36'$.

WATSONIA, in *Botany*, was so called by Miller, after the late Sir William Watson, knight, M.D. F.R.S., well known by his numerous papers in the Philosophical Transactions, on many subjects connected with the history of Botany, and eminently distinguished for his cultivation of several branches of philosophical and medical knowledge. Miller's genus being sunk by Linnæus in *Antholyza*, the *Büttneria* was called *Watsonia* by Boehmer; but the original one, restored by Mr. Ker, is now generally, and with great propriety, adopted.—Mill. Ic. 184. Ker in Sims and Kon. Ann. of Bot. v. 1. 229. Dryand. in Ait. Hort. Kew. v. 1. 93.—Class and order, *Triandria Monogynia*. Nat. Ord. *Enfata*, Linn. *Irides*, Juss.

Gen. Ch. *Cal.* Spatha inferior, shorter than the corolla, of two oblong, close-pressed, permanent valves. *Cor.* of one petal, superior: tube cylindrical throughout, somewhat enlarged, but not spreading, in the elongated throat, curved: limb nearly regular, in six deep, flat, spreading, almost equal segments. *Stam.* Filaments three, inserted into the tube at the origin of the throat, thread-shaped, ascending, shorter than the corolla; anthers oblong, somewhat parallel, incumbent. *Pist.* Germen inferior, oblong, furrowed; style thread-shaped, longer than the stamens; stigmas three, slender, deeply cloven, spreading, recurved. *Peric.* Capsule oblong, bluntly triangular, cartilaginous, of three cells and three valves. *Seeds* numerous, imbricated downwards, angular in their lower part, dilated into more or less of a wing at the upper end.

Ell. Ch. Spatha of two valves. Corolla tubular, with a cylindrical throat; its limb in six deep, nearly equal, segments. Stigmas three, thread-shaped, deeply cloven, the segments recurved. Capsule cartilaginous. Seeds numerous, angular.

This genus differs from *GLADIOLUS* in its almost regular corolla, with a cylindrical throat; narrow, divided, not dilated, stigmas; and angular, scarcely winged, seeds: *ANTHOLYZA*, as now limited, is distinguished from it, by having a ringent limb, of unequal and dissimilar segments; simple stigmas; and nearly globular seeds. See those articles.

1. *W. spicata*. Hollow-leaved *Watsonia*. Ker in Curt. Mag. at p. 553. Ait. n. 1. (*Ixia spicata*; Willd. Sp. Pl. v. 1. 200. I. *cepacea*; Redout. Liliac. t. 96. I. *fistulosa*; Curt. Mag. t. 523. I. *alopecuroides*; Linn. Suppl. 92. *Gladiolus spicatus*; Linn. Sp. Pl. 53. Thunb. Gladiol. n. 13. *G. fistulosus*; Jacq. Hort. Schoenbr. v. 1. 8. t. 16.)—Leaves cylindrical, hollow.—Gathered by Thunberg, on the highest hills of Hottentot's Holland, at the Cape of Good Hope, flowering in December and January. By Sir Joseph Banks's herbarium, this species appears to have been cultivated by Mr. W. Malcolm, in 1791. It blooms in the European green-houses in May, but not very readily, often bearing small oat-like bulbs in the place of flowers. The bulb is small, round, with a fibrous coat. Stem leafy, from eight to twelve inches high. Leaves alternate, very remarkable for their cylindrical inflated form, gradually swelling upwards, obtuse, with a small point; their surface very smooth; their base sheathing. Flowers either light blue or pale purple, very numerous, closely imbricated in a two-ranked tapering spike, with reddish crenate sheaths. Corolla regular, expanding rather more than half an inch. We do not find that the stigmas of this plant are cloven, as the generic character requires, and we should rather have left it in *Ixia*, till it could otherwise have been disposed of. The same remark applies to the following. The name *spicata* is not so exclusively appropriate as *fistulosa* or *cepacea* would have been, but it is the oldest name, and liable to no objection. This is certainly, as far as we can make out, the original *Gladiolus spicatus* of Linnæus, though he, long after its publication, very inadvertently laid into his herbarium, under that name, a Siberian specimen of a small-flowered variety of *G. communis*.

2. *W. plantaginea*. Plantain-spiked *Watsonia*. Ker in Curt. Mag. t. 553. Ait. n. 2. (*Ixia plantaginea*; Willd. Sp. Pl. v. 1. 200. *Gladiolus alopecuroides*; Linn. Sp. Pl. 54. Amoen. Acad. v. 4. 301. Thunb. Gladiol. n. 14.)—Upper leaves linear-sword-shaped, many-ribbed: lowermost hollow, compressed. Flowers imbricated in two rows.—Gathered by Thunberg in several places near the town, at the Cape of Good Hope, often in the highways. This differs essentially from the species just described, in having the usual sword-shaped foliage of its natural order. Their flowers nearly resemble each other. These are in the present species either blue or white, very numerous, forming a dense two-ranked spike, with membranous-edged sheaths, recalling the idea of some kind of Plantain. Sometimes each stem bears two or three such spikes, which are then very large and luxuriant; but in our cultivated specimens they are usually solitary, as well as much smaller. The flowers are without scent.

3. *W. punctata*. Dotted-flowered *Watsonia*. Ker in Ann. of Bot. n. 1. Ait. n. 3. (*Ixia punctata*; Andr. Repof. t. 177.)—Leaves linear-awl-shaped, compressed. Spike about three-flowered.—Sent from the Cape of Good Hope, in 1800, by Mr. Niven, to his employer Geo. Hibern,

bert, esq. in whose green-house at Clapham it flowered the spring following. *Bulb* roundish, depressed. *Stem* leafy, slender, about a foot high. *Leaves* few, alternate, very narrow, spreading in two directions. *Flowers* agreeing in size and disposition with those of *Ixia maculata*, about three in number, of a fine purple, marked with dotted or beaded veins; their segments regular, elliptical, longer than the tube, three of them rather smaller than the rest. *Stigmas* three, deeply divided; or rather, we should say, six, strap-shaped, obtuse, revolute, downy. The character of the *stigmas* answers to *Watsonia*, but the habit is very unlike the other species.

4. *W. marginata*. Broad Bordered-leaved *Watsonia*. Ker in Curt. Mag. t. 608. Ait. n. 4. (*Gladiolus marginatus*; Linn. Suppl. 95. Willd. Sp. Pl. v. 1. 217. Thunb. Gladiol. n. 20.)—Leaves sword-shaped, with thick callous edges. Spike somewhat compound. Mouth of the corolla with six teeth.—Abundant on grassy hills at the Cape of Good Hope, as well as on the Table-mountain, and other elevated ground, flowering from October to December often in such profusion, as to cover the hills as it were with a beautiful rose-coloured carpet. *Thunberg*. In our green-houses it readily blossoms from June to August, especially if planted in deep pots, and as readily increases, being, as Mr. Ker observes, become within a few years one of the commonest of its tribe. The great size of the plant, its thick-edged leaves, not indeed well expressed in the Botanical Magazine, and the copious, rose-coloured flowers, smelling like Hawthorn, or Heliotrope, render this one of the most desirable and striking of the Cape bulbs. The corolla is regular, with a tube about equal to its limb, having a short cylindrical throat. *Stigmas* long, each in two divaricated revolute segments.

5. *W. rosea*. Pyramidal-spiked *Watsonia*. Ker in Ann. of Bot. n. 5. Curt. Mag. t. 1072. Ait. n. 5. (*Gladiolus glumaceus*; Thunb. Prodr. 186. Vahl Enum. v. 2. 105. *G. marginatus* δ ; Thunb. Gladiol. n. 20. *G. iridifolii* varietas; Jacq. Ic. Rar. t. 235. *G. pyramidatus*; Andr. Repof. t. 335.)—Leaves sword-shaped, thickened at the edges. Spike compound. Mouth of the corolla naked.—Native of the Cape of Good Hope. It appears to have flowered, for the first time in England, at the Dowager Lady de Clifford's, in August 1803. One of the largest of its tribe, being sometimes four feet high. We cannot wonder at this having been taken for a variety of the last, at least while the species of this difficult order of plants were but superficially examined. The present is, however, the larger and more stately plant of the two, with even more beautiful rose-coloured flowers, whose corolla wants the six marginal teeth round the mouth, which essentially distinguish the preceding.

6. *W. brevifolia*. Short-leaved *Watsonia*. Ker in Curt. Mag. t. 601. Ait. n. 6. (*Antholyza spicata*; Andr. Repof. t. 56. *Gladiolus testaceus*; Vahl Enum. v. 2. 105.)—Leaves ovate-sword-shaped, equitant, very short. Tube, throat, and limb, of the corolla equal in length; mouth naked.—Native of the Cape of Good Hope, from whence it was imported by Messrs. Lee and Kennedy, through the hands of Mr. Pringle of Madeira, in 1794. The leaves are about four, almost perfectly radical, remarkable for their shortness, being but two or three inches long, though near an inch wide; their edges cartilaginous, though very narrow. *Stem* twelve or eighteen inches high. *Spike* long, erect, simple, or sometimes branched, but not composed of little spikelets. *Flowers* of a tawny red, about the size of *W. marginata*, but the proportion of their tube, and especially their throat, is longer

compared with the limb. Their colour would lead us to expect some fragrance, in the evening at least, but this is said not to be the case. They have, however, the advantage of being much more lasting than some of their allies. The *stigmas* are deeply cloven.

7. *W. iridifolia*. Flag-leaved *Watsonia*. Ker in Ann. of Bot. n. 12. Ait. n. 7. (*Gladiolus iridifolius*; Jacq. Ic. Rar. t. 234. Willd. Sp. Pl. v. 1. 215, excluding the synonym of *G. cardinalis*.)— β . var. *fulgens*; Curt. Mag. t. 600. (*Antholyza fulgens*; Andr. Repof. t. 192. *Gladiolus marginatus* γ ; Thunb. Gladiol. n. 20.)—Throat of the corolla curved, longer than the tube, and rather longer than the acute limb. Leaves sword-shaped, erect, with a prominent midrib.—Native of the Cape of Good Hope, from whence it was sent by Mr. Masson, in 1795. The variety β is preferred, on account of the splendid scarlet colour of its flowers, in which alone it is said to differ from the pale greyish-flowered plant, figured by Jacquin. We have not seen the latter, but if the figure be correct, the tube, and the cylindrical throat, are, each of them, shorter in proportion to the sheath, and to the limb, than in the scarlet kind. The leaves in both are long, erect, and scarcely thickened at the edges, having more of a midrib than the several foregoing species. The spathas, in the scarlet variety, are not much above half the length of the slender tube, which is about two-thirds as long as the greatly-extended, cylindrical, curved, and strongly deflexed throat. The latter exceeds the length of the elliptical, acute, recurved, nearly equal, segments of the limb. Anthers violet. *Stigmas* cloven half way down, divaricated.

8. *W. Meriana*. Red *Watsonia*. Ker in Ann. of Bot. n. 11. Curt. Mag. t. 1194. Ait. n. 8. (*Watsonia*; Mill. Ic. t. 276. *Antholyza Meriana*; Linn. Sp. Pl. 54. Curt. Mag. t. 418. *Gladiolus Merianus*; Willd. Sp. Pl. v. 1. 214. Vahl Enum. v. 1. 94. Jacq. Ic. Rar. t. 230. Redout. Liliac. t. 11. *Meriana flore rubello*; Trew. Ehret. t. 40.)

β . *W. angusta*; Ker Ann. of Bot. n. 9. (*G. Merianæ* var. Jacq. Ic. Rar. t. 231.)—Throat of the corolla curved, rather longer than the tube, and longer than the obtuse limb; tube longer than the spathe. Leaves sword-shaped, erect, with a prominent midrib.—Native of the Cape of Good Hope. Raised from seed, before 1750, in Chelsea garden, by Miller, who first gave it the name of *Watsonia*. A large and handsome species nearly akin to the last, but sufficiently distinct, and characterized by the blunt segments of its corolla. The proper hue of the flowers is a peculiar salmon-coloured red, rather than a scarlet, as may be seen in Miller's and Jacquin's figures, and especially Curtis's t. 418. But the corolla varies in this respect, as well as in size, of which the two extremes are the Botan. Mag. t. 1194, and Jacq. Ic. Rar. t. 231. The latter, which we have never seen in England, was referred to this species by the late Mr. Dryander, from a drawing sent by Jacquin, how justly can only be a matter of opinion, unless living specimens were accurately compared. The species before us flowers with other Cape bulbs in May and June, increasing plentifully by offsets.

9. *W. humilis*. Crimson *Watsonia*. Mill. Ic. t. 297. f. 2. Ker in Curt. Mag. t. 631. 1195. Ait. n. 9. (*Gladiolus laccatus*; Jacq. Ic. Rar. t. 232. Willd. Sp. Pl. v. 1. 215.)—Throat of the corolla curved, rather longer than the acute limb; tube the length of the spathe. Leaves sword-shaped, erect, with a prominent midrib.—Native of the Cape of Good Hope, from whence the seeds were obtained by Miller, in 1754. Much smaller than several of the last described, being seldom above a foot high,

high, with linear *leaves*. The *flowers* are of a crimson, or rose-coloured, hue, not verging towards a scarlet, or tawny red. They vary in size, as may be seen by the two figures in the Botanical Magazine. The *throat* is correctly cylindrical; tube generally shorter than the *spatha*, not longer. We are obliged to content ourselves with the above specific characters, founded on the proportion of these parts, for want of better. Mr. Ker and Mr. Dryander have done much towards the correct discrimination of genera and species in this favourite tribe, but the subject is far from being exhausted.

10. *W. roseo-alba*. Long-tubed *Watsonia*. Ker in Curt. Mag. t. 537. Ait. Epit. 376. (*Gladiolus roseo-albus*; Jacq. Hort. Schoenbr. v. 1. 7. t. 13. Vahl Enum. v. 2. 93.)

β. Variegated with red. Ker in Curt. Mag. t. 1193. Ait. Epit. 376.—Tube about twice the length of the throat, limb, or *spatha*, making nearly a right angle with the throat. Leaves sword-shaped, with a midrib.—Native of the Cape of Good Hope. The *tube* is one and a half or two inches long, erect; throat suddenly deflexed, cylindrical, rather slender, an inch long; segments of the limb lanceolate, acute, the length of the throat. *Anthems* but just projecting out of the mouth of the flower, violet-coloured. *Stigmas* in linear segments. The *corolla* is either cream-coloured, with rose-coloured tints about the mouth and throat, or flesh-coloured blotched with scarlet, or all over crimson. The *flowers* are more numerous and crowded than in *W. Meriana* and its allies. We cannot doubt the distinctness of this species.

11. *W. aletroides*. Aletris-flowered *Watsonia*. Ker in Ann. of Bot. n. 7. Ait. n. 10. Curt. Mag. t. 533. (*Gladiolus tubulofus*; Jacq. Ic. Rar. t. 229. *Antholyza tubulosa*; Andr. Repof. t. 174. *A. Merianella*; Curt. Mag. t. 441, excluding the reference to Miller.)—Throat deflexed, four times as long as the segments of the limb.—Found at the Cape of Good Hope by Mr. Masson, who sent bulbs to Kew garden in 1774. This elegant species bears numerous drooping *flowers*, of a rich crimson, sometimes speckled with a darker tint, or with white, and remarkable for their small slightly-spreading *limb*, so short in proportion to the long tubular deflexed *throat*, that they resemble the flowers of an *Alettris* or *Aloe*. The *leaves* are sword-shaped, narrow, with a central rib not very strongly marked, and several small lateral ones.

12. *W. stridiflora*. Straight-flowered *Watsonia*. Ker in Curt. Mag. t. 1406. Ait. Epit. 376.—Tube thread-shaped, twice the length of the *spatha*; throat erect, very short, slightly dilated; segments of the limb elliptical, obtuse, half the length of the tube. Leaves sword-shaped, with a prominent midrib.—Native of the Cape of Good Hope, from whence it was imported by the honourable W. Herbert. The *stem* is about twelve or eighteen inches high, with several shortish taper-pointed *leaves* at the bottom, and bears about two handsome crimson *flowers*, resembling some of the larger *Ixia*, in the shape, size, and posture of the *limb*, with a very long straight slender *tube*. *Stigmas* divided, as in true *Watsonia*, the only character in which this plant answers to the genus. On the contrary, *Gladiolus Watsonius*, Jacq. Ic. Rar. t. 233. Willd. Sp. Pl. v. 1. 214. Ait. v. 1. 96. Curt. Mag. t. 450 and 569, (see *GLADIOLUS*,) has every character and appearance of a *Watsonia*, even a regular *flower*, except the narrow deeply cloven *stigmas*. We are obliged, therefore, to confess, that these genera do not at present rest on any natural distinction, however different some of their species may be from each other.

WAT-TAUPAUMENE, or ST. PETER, in *Geography*, a river of North America, which runs into the Mississippi, N. lat. 44° 42'. W. long. 93° 38'.

WATTEAU, ANTHONY, in *Biography*, one of the most agreeable painters of the French school, was born at Valenciennes in 1684. His parents were in indigent circumstances, and he was placed with an obscure artist in his native city, to cultivate a talent which manifested itself early. When he was about 16 years old, having already surpassed his preceptor, he connected himself with a scene-painter on his way to Paris, and for some time assisted his associate in decorating the opera-house in that city. When this engagement was completed Watteau found it difficult to rescue himself from the obscurity and embarrassment into which he fell, when happily he became acquainted with Claude Gillot, a painter of grotesque and fabulous subjects, who was pleased with his works and disposition. Gillot afforded him an asylum in his own house, and then instructed him in all he knew of the art, and found an apt and agreeable scholar in his protégée. With the help he thus received from Gillot, and his own admiration and attentive study of the Luxembourg gallery, he formed a taste for colouring, which if not as grand, is at least as agreeable, as ever was employed by any one.

He attempted to prepare himself for historical painting, and studied at the academy with that view; he even was so successful as to obtain the first prize there for an historical picture; but happily he discovered a character of subject quite original and exactly suited to his taste, for which he wisely deserted history, and which has since formed plenty of aspirants, but has never been so successfully practised. The theatre, the opera, fêtes champêtres, masquerades, pantomimes, puppet-shows, afforded him his figures; the gardens of the Luxembourg and of the Thuilleries, of Versailles and St. Cloud, furnished the scenes. In these nature prevails only in the colouring, and that is exquisite, rich, delicate, clear, and full; bright without gaudiness, and deep without blackness; laid on with a freedom, fulness, and delicacy of touch, which no one ever surpassed; but the airs of his figures are generally affected to the highest degree; people of rank and fashion, aping the enjoyments of rural life: and when he attempted to paint domestic or rural scenes, he carried the same taste into his practice. The true character of Watteau's pictures is French gentility, gay, cheerful, debonnaire, of which self-satisfaction is the surest basis. "In his halts and marches of cavalry, the careless strut of his soldiers retains the air of a nation that aspires to be agreeable as well as victorious." Watteau visited England in the reign of George I., but did not enjoy his health here, and returned to France in about a year, where he died in 1721, at the early age of 37.

WATTEN, in *Geography*, a town in Scotland, in the county of Caithness; 7 miles N.W. of Wick.—Also, a town of France, in the department of the North, on the Aa; 4 miles N. of St. Omer.

WATTENSCHIED, a town of Germany, in the county of Mark; 5 miles S.W. of Bockum.

WATTER, a river which rises in the county of Waldeck, and runs into the Erpe, near Volckmarfen.

WATTERPUTTEN, a town of Hindoostan, in Concan; 5 miles S. of Geriah.

WATTINAD, a town of Hindoostan, in the Carnatic; 20 miles S.S.E. of Tanjore.

WATTLE, in *Agriculture and Rural Economy*, a kind of hurdle formed by means of split wood, or small rods, and used for making folds for sheep. The term also signifies a fleshy excrescence growing from under the top of the throats

of animals, such as the cock, turkey, and some others. See HURDLE.

WATTLE-Bird. See *GLAUCOPIS Cinerea*.

WATTLES, in *Rural Economy*, a term applied, in some places, to the rods that are laid upon a roof to be thatched on. This is found an useful and cheap mode for farm buildings in some of the southern districts. See THATCHING.

WATTON, in *Geography*, a small market-town in the hundred of Wayland and county of Norfolk, England, is situated on the confines of what is called the Filand, or open part of the county, at the distance of 21 miles W. by S. from Norwich, and 91 miles N.N.E. from London. Since the making of the turnpike-road through the hundred, Watton has become a place of considerable thoroughfare. It has three annual fairs, and a respectable weekly market on Wednesdays. Great quantities of butter are sent hence for the supply of the London markets. In the enumeration of the population for the year 1811, the parish was stated to contain 177 houses, with a population of 794 persons. The church is very small, being only twenty yards long and eleven broad: the tower is round at the bottom, and octangular at the top. Blomefield was induced, from the appearance of the church, to suppose it was erected so early as the reign of Henry I. It stands at a distance from the town, near the site of the old manorial house; and was evidently so placed to accommodate the tenants of the several hamlets belonging to the manor. On the 25th of April 1673, a dreadful fire happened in the town, when above sixty houses were burnt down, besides outhouses, &c. to the damage of 7450*l.*, and goods to the further value of 2660*l.*: for which a brief was granted to collect throughout England for two years.—Blomefield's *Essay towards a Topographical History of Norfolk*, vol. 2. 8vo. 1805. *Beauties of England and Wales*, vol. xi. Norfolk. By Rev. J. Evans, and J. Britton, F.S.A.

WATTS, ISAAC, D.D. in *Biography*, a Nonconformist divine, eminently distinguished for talents and piety, was born at Southampton in 1674, where, under the tuition of a clergyman of the established church, he made rapid progress in the Latin and Greek languages, and acquired some knowledge even of Hebrew. When it was proposed by some gentlemen who were apprized of his proficiency, to bear the charges of his education in one of the English universities, he declared his purpose of continuing among the Dissenters, though his father, who was of that profession, had often suffered persecution; and at the age of sixteen he was placed under the care of the Rev. Thomas Rowe, who kept an academy in London. Twenty-two Latin dissertations on metaphysical and theological subjects, found among his papers, afford ample evidence of his zealous application during his connection with this institution. Of his poetical talents at the early age of fifteen years several specimens have been preserved, and more particularly a Pindaric ode, addressed to his preceptor Mr. Pinhorn. At the age of twenty he finished his academical studies, and resided with his father for two years with a view to farther improvement. At this time he was invited to become private tutor to the son of sir John Hartopp, bart. at Stoke-Newington near London, and in this situation he continued for five years, gaining universal esteem, cultivating a friendship with his pupil which lasted through life, and connecting with the discharge of his office the study of the scriptures in the original languages. Although he was well qualified for the public exercise of his ministry, such was his diffidence that he would not venture to ascend the pulpit till he had completed his twenty-fourth year, at which time he was chosen assistant to Dr. Isaac Chauncy, whom he succeeded as pastor in the year 1702. His constitution was so delicate that he could not undertake the whole service, and the attack of a

fever in 1712 disqualified him for his public duties for four years. In this state of debility he was kindly received in the house of sir Thomas Abney, where the indulgent treatment of this gentleman and his lady contributed to restore his health and spirits. In this hospitable mansion he not only found a temporary asylum, but a permanent abode for the remaining thirty-six years of his life. Here he enjoyed every comfort which friendship and liberality could bestow, and which, by repairing his enfeebled frame, enabled him to resume his services in public and to prosecute his private studies, no less to the improvement and satisfaction of those with whom he was immediately connected, than to the benefit of the world; inasmuch that few persons have acquired a more extensive and a more permanent popularity, as it respects the interests both of literature and of religion. His reputation attracted the notice of both the universities of Edinburgh and Aberdeen, and they seemed to vie with each other which should first confer upon him the honour of the degree of doctor in divinity, and he received it from these two universities in the year 1728. His constitution, though in some degree renovated by the attention and kindness which he experienced, was still so delicate and feeble, that he found it necessary to remit, and at length to resign his ministerial duties; but his congregation testified their respect for him by declining to accept his offer of the renunciation of his usual salary. However, he gradually declined, and calmly expired at Stoke Newington, November the 25th, 1748, in the 75th year of his age.

Dr. Watts was a man of lively fancy, warm feelings, and a comprehensive understanding, and distinguished by that versatility of talents and pursuits, which enabled him to acquire a considerable degree of reputation in various departments of literature, but which prevented his arriving at a supereminent rank in any. The characteristic quality of his mind, manifested in his numerous productions, was a devotional spirit. Of his "*Horæ Lyricæ*," the greatest number belongs to the devotional class, and in these his ardent feelings and imagination have sometimes transported him beyond the bounds which a correct taste and sound judgment would have prescribed. The same observation may be also applied to his "*Psalms and Hymns*," and more especially to the latter, which were juvenile compositions, and in which a sober reader will be disgusted with the contrast that is exhibited between the wrath of the Supreme Being and the benignity of the Son of God; as if the Deity were inclined to punish his offending creatures with everlasting punishment, and the Son were disposed to rescue and save them. Many of the psalms and hymns, however, are admirably adapted to Christian worship, and a select collection of them, which has been lately made by some ministers in London, and which they have enriched by extracts from other sources, is less exceptionable in a variety of respects than either the psalms or hymns even of Dr. Watts in their original state; and in these devotion and poetry are more happily combined for the worship of Dissenters and even of Churchmen than in the psalmody of the establishment. Many of Watts's lyric productions possess considerable poetical merit, and display a fertility and elegance of fancy. His "*Divine Songs for Children*" have been widely circulated, and are well calculated to interest and impress youthful minds; and they are, generally speaking, unexceptionable, though not incapable of castigation and improvement.

The doctor's philosophical publications are numerous, and most of them are well known. Among these we may reckon his "*Logic*," and the supplement to it, entitled the "*Improvement of the Mind*;" "*A Discourse on Education*;" "*An Elementary Treatise on Astronomy and Geography*;"

“Philosophical Essays on various Subjects, with Remarks on Locke’s Essay on the Human Understanding;” and “A brief Scheme of Ontology.” His other works are chiefly theological, consisting of Sermons, Discourses, Essays, and Controversial Tracts, &c. His scheme of theology was undoubtedly that which is usually called orthodoxy, and, to say the least of it, approaching to Calvinism. His temper, however, was kind and gentle, and his moderation was increasing as he advanced in years, and the maturity of his judgment restrained and controlled the fervour of his feelings and passions. Some have said that towards the close of life his sentiments, with regard to the doctrine of the Trinity, were materially altered. This, however, is a question *sub judice*. Whilst it is needless in this place to enter into the dispute, and to examine the allegations *pro* and *con*, we incline to think, as far as we have had an opportunity of examining the evidence, that the supposition of some degree of change is not improbable. The printed Works of Dr. Watts, together with those which were left in M.S. for the revision of Dr. Jennings and Dr. Doddridge, were published collectively by Dr. Gibbons, in 6 vols. 4to. 1754. We shall conclude this article with the words of one of his biographers. “To whatever class Dr. Watts belongs,” ranked by this biographer among the decided advocates for orthodoxy, “he must always be regarded as one of those whose whole heart was devoted to the promotion of the best interests of mankind, and whose life would have done honour to any system of opinions.” Gibbons’s Memoirs of Watts. Johnson’s Lives of the Poets. Gen. Biog.

WATTS, in *Geography*, a town of Virginia; 30 miles N. W. of Alexandria.—Also, a town of the state of Georgia. N. lat. $34^{\circ}22'$. W. long. $86^{\circ}25'$.

WATTS *Island*, a small island in the Chesapeake. N. lat. $37^{\circ}54'$. W. long. $76^{\circ}3'$.

WATTUSKIFLET, a channel of the Baltic, between the island of Aland and the coast of Finland, abounding with small islands.

WATWEILER, or WATTERWEILER, a town of France, in the department of the Upper Rhine. Near it is a medicinal spring; 16 miles S. of Colmar.

WAU, a town of Hindoostan, in the circle of Werrear; 24 miles N. of Radunpour.

WAU-CA-HATCHO, or COW-TAIL *River*, a river of Louisiana, which is the last stream of any consequence that enters the Sabine.

WAVE, UNDA, in *Physics*, a cavity in the surface of the water, or other fluid, with an elevation on its sides. Or, it is a volume of water elevated by the action of the wind upon its surface, into a state of fluctuation.

The origin of waves may be thus conceived. The surface of a standing water being naturally plain, and parallel to the horizon, (allowing for that small degree of curvature which results from its gravitation to the centre,) if by any means it be rendered hollow, as at A, (*Plate XV. Hydraulics*, fig. 11.) its cavity will be surrounded with an elevation B B; for if a certain quantity of water be depressed below the usual level, an equal quantity must rise in some other place above that level, and the water which stands closest to the place of the original impression will of course be moved. The raised water will descend by its gravity, and, with the celerity acquired in descending, will form a new cavity; by which motions, the water will ascend at the sides of this cavity, and fill the cavity A, while there is a new elevation towards C; and, when this last is depressed, the water rises anew towards the same part. Thus arises a successive motion in the surface of the water; and a cavity, which carries an elevation before it, is moved along from A,

towards C. Thus the alternate rising and falling of the water in ridges will extend all round the original source of motion; but as they recede from that place, so the ridges, as well as the adjoining hollows, become smaller and smaller, until they vanish. This diminution of size is produced by three causes; *viz.* by the want of perfect freedom of motion amongst the particles of water, by the resistance of the air, and by the further ridges being larger in diameter than those which are nearer. It is likewise on account of the friction, or adhesion, among the particles of water, and of the resistance of the air, that, in the same place, the alternate elevations and depressions diminish gradually, until the water re-assumes its original tranquillity, unless the external impression be renewed or continued. This cavity, with the elevation next it, is called a *wave*; and the space taken up by the wave on the surface of the water, and measured according to the direction of the wave’s motion, is called the *breadth of the wave*; which is evidently equal to the distance between the tops of contiguous ridges, or between the lowest parts of two contiguous hollows; and a wave is said to *have run its breadth*, when its elevated part is arrived at the place where the elevated part of the next wave stood before, or (the situations of two contiguous waves being given) when one of them is arrived at the place of the other; and the time which is employed in this transition is called *the time of a wave’s motion*.

WAVES, *the Motion of*, forms an article in the new philosophy; and its laws being now pretty well determined, we shall give the reader the substance of what is taught on this subject.

1. The cavity, as A, is encompassed every way with an elevation; and the motion above-mentioned expands itself every way: therefore the waves are moved circularly.

2. Suppose, now, A B (*fig. 12.*) an obstacle, against which the wave, whose beginning is at C, strikes; and we are to examine what change the wave suffers in any point, as E, when it is come to the obstacle in that point. In all places through which the wave passes in its whole breadth, the wave is raised; then a cavity is formed, which is again filled up; which change while the surface of the water undergoes, its particles go and return through a small space: the direction of this motion is along C E, and the celerity may be represented by that line. Let this motion be contrived to be resolved into two other motions, along G E and D E, whose celerities are respectively represented by those lines. By the motion along D E, the particles do not act against the obstacle; but, after the stroke, continue their motion in that direction with the same celerity; and this motion is here represented by E F, supposing E F and E D to be equal to one another; but by the motion along G E, the particles strike directly against the obstacle, and this motion is destroyed: for though the particles are elastic, yet, as in the motion of the waves they run through but a small space, going backward and forward, they proceed so slowly, that the figure of the particles cannot be changed by the blow; and so are subject to the laws of percussion of bodies perfectly hard. See PERCUSSION.

But there is a reflection of the particles from another cause: the water which cannot go forward beyond the obstacle, and is pushed on by that which follows it, gives way where there is the least resistance; that is, it ascends; and this elevation, which is greater in some than other places, is caused by the motion along G E; because it is by that motion alone that the particles impinge against the obstacle. The water, by its descent, acquires the same velocity with which it was raised; and the particles of water are repelled from the obstacle with the same force in the direction E G,

as that with which they struck against the obstacle. From this motion, and the motion above-mentioned along EF , arises a motion along EH , whose celerity is expressed by the line EH , which is equal to the line CE ; and by the reflection, the celerity of the wave is not changed, but it returns along EH , in the same manner as if, taking away the obstacle, it had moved along Eh .

If from the point C , CD be drawn perpendicular to the obstacle, and then produced, so that Dc shall be equal to CD , the line HE continued will go through c ; and as this demonstration holds good in all points of the obstacle, it follows, that the reflected wave has the same figure on that side of the obstacle, as it would have had beyond the line AB , if it had not struck against the obstacle. If the obstacle be inclined to the horizon, the water rises and descends upon it, and suffers a friction, by which the reflection of the wave is disturbed, and often wholly destroyed; and this is the reason why very often the banks of rivers do not reflect the waves.

If there be a hole, as I , in the obstacle BL , the part of the wave which goes through the hole, continues its motion directly, and expands itself towards QQ ; and there is a new wave formed, which moves in a semicircle, whose centre is the hole. For the raised part of the wave, which first goes through the hole, immediately flows down a little at the sides; and, by descending, makes a cavity which is surrounded with an elevation on every part beyond the hole, which moves every way in the same manner as was laid down in the generation of the first wave.

In the same manner, a wave to which an obstacle, as AO , is opposed, continues to move between O and N , but expands itself towards R , in a part of a circle, whose centre is not very far from O . Hence, we may easily deduce what must be the motion of a wave behind an obstacle, as MN .

Waves are often produced by the motion of a tremulous body, which also expand themselves circularly, though the body goes and returns in a right line; for the water which is raised by the agitation, descending, forms a cavity, which is every where surrounded with a rising.

Different waves do not disturb one another, when they move according to different directions. The reason is, that whatever figure the surface of the water has acquired by the motion of the waves, there may in that be an elevation and depression; as also such a motion as is required in the motion of a wave.

To determine the celerity of the waves, another motion, analogous to their's, must be examined. Suppose a fluid in the bent cylindric tube EH (*fig. 13.*); and let the fluid in the leg EF be higher than in the other leg by the distance IE ; which distance is to be divided into two equal parts at i . The fluid, by its gravity, descends in the leg EF , while it ascends equally in the leg GH ; so that when the surface of the fluid is arrived at i , it is at the same height in both legs; which is the only position in which the liquid can be at rest; but by the celerity acquired in descending, it continues its motion, and ascends higher in the tube GH ; and in EF is depressed quite to l , except so much as it is hindered by the friction against the sides of the tube. The fluid in the tube GH , which is higher, also descends by its gravity, and so the fluid in the tube rises and falls, till it has lost all its motion by the friction.

The quantity of matter to be moved is the whole fluid in the tube; the moving force is the weight of the column IE , whose height is always double the distance Ei ; which distance, therefore, increases and diminishes in the same ratio with the moving force. But the distance Ei is the space to

be run through by the fluid, in order to its moving from the position EH , to the position of rest; which space, therefore, is always as the force continually acting upon the fluid: but it is demonstrated, that it is on this account that all the vibrations of a pendulum, oscillating in a cycloid, are isochronal; and, therefore, here also, whatever be the inequality of the agitations, the fluid always goes and returns in the same time. The time in which a fluid thus agitated ascends, or descends, is the time in which a pendulum vibrates, whose length is equal to half the length of the fluid in the tube, or to half the sum of the lines EF , FG , EH . This length is to be measured in the axis of the tube. See **PENDULUM.**

From these principles, to determine the celerity of the waves, we must consider several equal waves following one another immediately; as A , B , C , D , E , F , (*fig. 14.*) which move from A towards F : the wave A has run its breadth, when the cavity A is come to C ; which cannot be, unless the water at C ascends to the height of the top of the wave, and again descends to the depth C ; in which motion, the water is not agitated sensibly below the line bi : therefore, this motion agrees with the motion in the tube above-mentioned; and the water ascends and descends, that is, the wave goes through its breadth, while a pendulum of the length of half BC performs two oscillations, or while a pendulum of the length BCD , that is, four times as long as the first, performs one vibration; since the times in which pendulums of different lengths perform their vibrations are as the squares of their lengths. (See **VIBRATION.**) Therefore, the celerity of the wave depends upon the length of the line BCD ; which is greater, as the breadth of the wave is greater, and as the water descends deeper in the motion of the waves. In the broadest waves, which do not rise high, such a line as BCD does not much differ from the breadth of the wave; and in that case a wave moves its breadth, while a pendulum, equal to that wave, oscillates once. Hence, if the breadth of a wave be 39.1196 inches, (this being the length of a pendulum which vibrates seconds,) then that wave will move on at the rate of 39.1196 inches per second of time; that is, at the rate of 195 feet per minute, nearly.

In every equable motion, the space gone through increases with the time and the celerity; wherefore, multiplying the time by the celerity, you have the space gone through; whence it follows, that the celerities of the waves are as the square roots of their breadths: for as the times in which they go through their breadths are in that ratio, the same ratio is required in their celerities, that the products of the times, by their celerities, may be as the breadths of the waves, which are the spaces gone through.

Dr. Young is of opinion, that sir Isaac Newton's analogy, resulting from a comparison of a wave with the oscillation of a fluid in a bent tube, is too distant to admit our founding any demonstration upon it. LeGrange, he says, has investigated the motions of waves in a new and improved manner; and Dr. Young has also demonstrated a theorem similar to his, but, as he apprehends, more general and explicit. From these premises it appears, that, supposing the fluids concerned to be infinitely elastic, that is, absolutely incompressible, and free from friction of all kinds, any small impulse communicated to a fluid would be transmitted every way along its surface, with a velocity equal to that which a heavy body would acquire in falling through half the depth of the fluid; and he concludes, from observation and experiment, that where the elevation or depression of the surface is considerably extensive in proportion to the depth, the velocity approaches nearly to that which is thus determined,

mined, being frequently deficient one-eighth or one-tenth only of the whole. In other cases, where a number of small waves follow each other at intervals considerably less than the depth, he has endeavoured to calculate the retardation which must be occasioned by the imperfect elasticity or compressibility of the fluid; but it seems probable that the motion of small waves is still much slower than this calculation appears to indicate. Many of the phenomena of waves, says this ingenious author, may be very conveniently exhibited by means of a wide and shallow vessel, with a bottom of glass, terminated by sides inclined to the horizon; in order to avoid the confusion which would arise from the continual reflections produced by perpendicular surfaces. The waves may be excited by the vibrations of an elastic rod or wire, loaded with a weight, by means of which its motions may be made more or less rapid at pleasure; and the form and progress of the waves may be easily observed, by placing a light under the vessel, so that their shadows may fall on a white surface, extended in an inclined position. In this manner, the manifest inflection of the surface of the water may be made perfectly conspicuous.

This motion of the sea-water depends greatly on the winds, and on the situation of mountains, in regard to the sea; for the winds are driven back from these with great impetuosity; and in some places this occasions a great and very irregular undulation, beside that which is produced by the immediate action of the winds on the surface of the water in their own direct course.

Waves are to be considered as of two kinds, and these may be distinguished from one another by the names of *natural* and *accidental* waves.

The *natural* waves are those which are regularly proportioned in size to the strength of the wind, whose blowing gives origin to them. The *accidental* waves are those occasioned by the wind's reacting upon itself by repercussion from hills and mountains, or high shores, and by the washing of the waves themselves, otherwise of the natural kind, against rocks and shoals: all these causes give the waves an elevation, which they can never have in their natural state.

It seems to be pretty well determined, from a variety of experiments and observations, that the most violent wind never penetrates a great way into the water; and that in great storms the water of the sea is slightly agitated at the depth of 20 feet below the usual level, and probably not moved at all at the depth of 30 feet, or 5 fathoms; consequently the natural displacing of the waters by the wind cannot be supposed to reach nearly so low: and hence it should seem, that the greatest waves could not be so very high as they are represented by accurate and creditable navigators. Mr. Boyle found, upon inquiry, that when the wind was high, so that the waves were manifestly six or seven feet high above the surface of the water, no sign of agitation was perceived at the depth of 15 fathoms; but if the blast continued long, then the mud at the bottom was stirred, and the water became thick and dark. Persons who have remained for some time at a considerable depth have been surprised to find a storm, when they have returned to the upper parts of the water. At the depth of 12 or 15 feet, the agitation of the water has been accordingly diminished; and at a considerable distance from the shore, and in deeper water, the sea has been found proportionably calm and tranquil. It has also been found, that in a part of the sea often tempestuous, the storm did not reach with any efficacy four fathoms beneath the surface of the water. Boyle's Works, vol. iv. p. 354, 4to. Relations about the Bottom of the Sea, § 3.

Count Martigli measured carefully the elevations of the waves near Provence, and found that, in a very violent tempest, they arose only to seven feet above the natural level of the sea; and this additional foot in height, above the result of Mr. Boyle's deductions, he easily resolved into the accidental shocks of the water against the bottom, which was, in the place he measured them in, not so deep as to be out of the way of affecting the waves; and he allows that the addition of one-sixth of the height of a wave, from such a disturbance from the bottom, is a very moderate alteration from what would have been its height in a deep sea; and concludes, that Mr. Boyle's calculation holds perfectly right in deep seas, where the waves are purely natural, and have no accidental causes to render them larger than their just proportion.

In deep water, under the high shores of the same part of France, this author found the natural elevation of the waves to be only five feet; but he found also that their breaking against rocks, and other accidents to which they were liable in this place, often raised them to eight feet high.

We are not to suppose, from this calculation, that no wave of the sea can rise more than six feet above its natural level in open and deep water; for waves immensely higher than these are formed in violent tempests in the great seas. These, however, are not to be accounted waves in their natural state, but they are single waves formed of many others; for in these wide plains of water, when one wave is raised by the wind, and would elevate itself up to the exact height of six feet, and no more, the motion of the water is so great, and the succession of waves so quick, that, during the time this is rising, it receives into it several other waves, each of which would have been at the same height with itself: these run into the first wave one after the another, as it is rising; and by this means its rise is continued much longer than it naturally would have been, and it becomes accumulated to an enormous size. A number of these complicated waves arising together, and being continued in a long succession by the continuation of the storm, makes the waves so dangerous to ships, which the sailors in their phrase call mountains high. Martigli, Hist. Phys. de la Mer.

When it blows fresh, the waves not moving with sufficient rapidity, their tops, which are thinner and lighter, are impelled forward, broken, and changed into a white foam, particles of which, called the "spray," are carried a great way. Waves, with regard to their form, are circular or straight, or otherwise bent, according as the original impression is made in a narrow space nearly circular, or in a straight line, or in other configurations. In open seas the waves generally are in the shape of straight furrows, because the wind blows upon the water in a parallel manner, or at least for a long apparent tract. The same causes which raise water into waves must evidently produce the like effect on other fluids, but in various degrees, as the fluid is more or less heavy, as its particles adhere more or less forcibly to each other, and probably likewise as there is a greater or less degree of attraction between the fluid and the other body which gives it the impulse. If it be attempted to raise waves upon oil by the force of wind, it will be found very difficult to succeed in a similar degree. This difficulty is probably owing to the natural attraction of the particles of oil; and besides, there may be less attraction between oil and air than between the latter and water, for water always contains a certain quantity of air; and if it be deprived of that air by boiling, or otherwise, a short exposure to the atmosphere will enable the water to imbibe it. It is likewise probable, that the surface of water, even when stag-

nant, may not be so smooth as the surface of oil, so that the wind may more easily catch into the inequalities of the former than the latter. Hence it is that the effect of the wind upon waves may in a great degree be prevented or moderated, by spreading a thin film of oil on the surface of the water. For an account of this operation and its effects, see OIL.

WAVE-*Offering*, among the *Jews*, a sacrifice offered by agitation or waving towards the four cardinal points.

To WAVE, is used, in the *Sea-Language*, for the making signs for a vessel to come near, or keep off.

WAVED, or WAVY, a term in *Heraldry*, when a bordure, or any ordinary or charge in a coat of arms, has its outlines indented, in manner of the rising and falling of waves. This is also called *undy, undé, or ondé*, and denotes that the frist of the family in whose arms it stands, acquired his honours for sea services, and has this peculiar commemoration of it ordered in his arms.

WAVED *Hair-Grafs*, in *Agriculture*, a sort of grafs which is found to be pretty productive on mountain heathy lands, and which abounds pretty much in nutritive matter, but which loses considerably in its weight in drying, according to the trials which have lately been made on grafses at Woburn. See AIRA *Flexuosa*.

WAVELLITE, in *Mineralogy*, a mineral first discovered at Barnstaple, in Devonshire, by Dr. Wavell, and since found in various other situations. From its appearance, it has been classed by Mr. Jamefon as a member of the zeolite family. See ZEOLITE.

Wavellite occurs in a botryoidal, stalactical, and globular form; also crystallized in very oblique four-sided prisms, flatly bevelled on the extremities: the bevelling planes are set on the obtuse lateral edges. The prisms are sometimes deeply truncated on the obtuse lateral edges. Wavellite occurs also in fibres, or acicular prisms, diverging from a common centre, and either separated or adhering laterally to each other, composing hemispherical concretions of various sizes, to the magnitude of a bullet. The lustre of wavellite is pearly, more or less shining. The colour is yellowish-white, greyish-white, and greenish-white; it is translucent. This mineral is brittle, and, according to professor Jamefon, it is sufficiently hard to scratch quartz: others ascribe to it a lower degree of hardness. Before the blow-pipe it becomes soft and opaque, but neither decrepitates nor fuses. It is soluble by the assistance of heat in the mineral acids, in which it effervesces and leaves very little residue. The specific gravity of wavellite varies from 2.22 to 2.70.

The most remarkable peculiarity of this mineral is its composition; wavellite being nearly a pure hydrat of alumine; but some specimens contain a trace of fluoric acid. When fragments of the English or Irish wavellite are laid upon a glass plate, and a drop of sulphuric acid is added, the glass is slightly corroded on the application of heat, indicating the presence of the above-mentioned acid.

The constituent parts of wavellite are given as under:

Wavellite from Barnstaple.		
Alumine	- 71.50	70
Oxyd of iron	.50	
Lime	-	1.4
Water	- 28.	26.2
	100 Klaproth.	97.6 Davy.

	Cornish Wavellite.	South American Wavellite.
Alumine	- 58.70	68.
Oxyd of iron	0.19	1.
Lime	- 0.37	
Silex	- 6.12	4.50
Water	- 30.75	
Lofs	- 3.87	26.50
	100 Gregor.	100 Klaproth.

Wavellite occurs in veins in the granite of Cornwall, with fluor-spar, quartz, tin-stone, and copper pyrites. At Barnstaple, in Devonshire, it occurs in soft slate. Several mineralogists consider wavellite as a variety of the same mineral, which Hauy has called diaspore.

WAVENEY, in *Geography*, a river of England, in the county of Suffolk, which joins the Yare, at its mouth.

WAVEREN, a town of France, in the department of the Scheld, on the Dyle. By war and accidental fires much decayed; 12 miles S. of Louvain.

WAVERS, in *Rural Economy*, a term used to signify the young timber-trees, or timberlings as they are mostly called, that are left standing for further growth, in felling or cutting over woods of different kinds. See TIMBER.

WAVESON, in the *Admiralty-Law*, a term used for such goods, as, after shipwreck, appear swimming on the waves.

WAVIGNIES, in *Geography*, a town of France, in the department of the Oise; 10 miles N. of Clermont.

WAUKEAGUE, a town of the district of Maine, near the coast; 5 miles W. of New Bristol.

WAUNGLY, a town of Hindoostan, in Vissiapour; 10 miles S.E. of Currer.

WAVY, in *Botany*, is synonymous with *repandum* and *undulatum*; in the first instance, it expresses an undulating outline, with an even surface; in the second, an undulating surface, caused by the marginal region of a leaf, or petal, being more ample or luxuriant than the central part, or base. The latter is often the case with cultivated plants, as *Malva crispa*, and the different curled varieties of cabbage, brocoli, parsley, mint, &c.

WAVY, in *Heraldry*. See WAVED.

WAWAY, in *Geography*, a small island in the East Indian sea, near the E. coast of the island of Celebes, about 40 miles in circumference. S. lat. 4° 8'. E. long. 123° 30'.

WAWARSING, a large township of New York, in the south-west angle of Ulster county, 25 miles S.W. of Kingston, erected in 1806, from the S.W. part of Rochester, and lying on the W. of the Shawangunk mountain. Plumbago, of a good quality, is found in this township, and here are many indications of iron-ore. Here are several small settlements, as at Warwasing, Napenagh, and Lurenkill; but much of the land is uncultivated. Here are one Dutch reformed church, and eight or ten school-houses. In 1812, the whole population consisted of 1335 persons, and the number of electors was 117; and here were 74 looms in families, which produced 18,047 yards of cloth.

WAWIACHTANOS, Indians of America, inhabiting chiefly between the rivers Wabash and Sciota.

WAWRA, a small negro town of Africa, properly belonging to Kaarta, but when Park visited it, tributary to Maafong, king of Bambarra. It is surrounded with walls, and inhabited by a mixture of Mandingoes and Foulahs. The inhabitants are chiefly employed in cultivating corn, which they

they exchange with the Moors for salt; 60 miles E.S.E. of Benowm.

WAX, a term which comprehends two or three substances, differing in their nature and origin, and yet possessing several common properties. The common properties of the animal and vegetable productions, of which we shall give a brief account in the sequel of this article, are fusibility at a moderate heat; when kindled, burning with much flame; insolubility in water; solubility in alkalies, and also in alcohol and ether; in which two latter properties all the species of wax differ from the concrete oils, to which in other respects they bear a very strong resemblance. The most important, and most generally known and used of these substances, is

Bees' wax, excreted from the body of the bee, and employed by these insects in the construction of their cells, both for the accommodation of their young and the deposition of their honey. Of this substance, a young hive will yield at the end of the season about a pound of wax; and an old hive about twice as much. The finest wax is that which is made in dry, heathy, or hilly countries; but in parts abounding with vineyards it is decidedly inferior. Although the commonly received notion, which ascribes this substance to the elaboration of the pollen of flowers, which the bees visibly collect on their thighs, had received the sanction of observers not less distinguished than Bonnet and Reaumur (see *PAIN D'Abeilles*), yet the Lufatian Society, as long ago as the year 1768, was not unacquainted with the fact, that the wax, instead of being discharged from the mouth, is secreted in the form of thin scales among the abdominal rings or segments. In 1792, the celebrated Mr. John Hunter detected the genuine reservoir of the wax under the belly of the bees, and gave an account of his observations in the *Philosophical Transactions*, (vol. lxxxii. part 1.) On elevating the lower segments, he observed plates of a fusible substance, which he ascertained to be wax; and he was convinced, that an essential difference subsists between the pollen, which these little creatures collect with so much care and industry in the form of pellets on their thighs, and the matter of which the combs are constructed. This curious subject has been further investigated by Messrs. Huber, father and son; and they have demonstrated the organs in which the wax is secreted, though they had eluded the perspicuity of Swammerdam, Hunter, and other acute anatomists. These sacklets, or small compartments, now minutely explained and illustrated by engravings, are peculiar to the working bees, which alone produce wax; and each individual is furnished with eight of them. The waxy matter, as it occurs in a transfused state in the secretory organs, differs from the fresh wax of the combs only in being of a less compounded nature, which has been ascertained by trials with spirit of turpentine and sulphuric ether. Prosecuting these reflections, our ingenious authors concluded that the common opinion was probably erroneous; because, like Hunter, they had observed swarms, newly placed in the empty hives, construct their combs without fetching home any pollen; while the bees of old hives, where no fresh cells were required, nevertheless provided an ample stock of this powder. In order, however, to determine the point more directly, they confined a recent swarm within an empty straw-hive, leaving at their disposal only a sufficiency of honey and water for their consumption, and preventing them from going beyond the precincts of a well-closed room; when, in the short space of five days, they had constructed five cakes of a beautiful white though very fragile wax. This experiment was repeated, and was uniformly accompanied by similar results; and therefore they no longer hesi-

tated in admitting the fact, that honey, through the organic intervention of bees, may be converted into wax. In order to determine whether vegetable pollen, also, was susceptible of this conversion, the honey was wholly removed, and the confined bees were fed on fruits and pollen, of which last a large store was left at their disposal; but, though they continued in this situation during eight days, they neither made any wax, nor exhibited any plates under their abdominal rings. Having suspected that the secretion of wax originated in the cohesive principle contained in honey, our authors recurred to various experiments, which constantly proved that sugar alone was an excellent substitute for honey, and, on some occasions, afforded a superior wax. They afterwards found, that bees, when left at perfect liberty to roam abroad, act precisely on the same principle in the construction of their combs; and they also discovered, that labourers of two descriptions exist in each hive. The first, susceptible of acquiring considerable dimensions, when they have received all the honey which their stomachs can contain, are principally destined to the elaboration of the wax; while the second, whose abdomen undergoes no sensible change of bulk, neither gather nor retain more honey than is necessary for immediate subsistence, and readily share that which they collect with their companions; who take no charge of storing the hive with provisions, their appropriate office being to attend the young. These they call nursing or small bees, in contradistinction to those with dilated bellies, and which, as they say, are entitled to the appellation of "wax-workers." The existence and separate offices of these two sorts of bees were sufficiently ascertained. When the hives are filled with combs, the wax-working bees discharge their honey into the usual magazines, and produce no more wax; but, if they have no receptacle in which they can deposit it, and if the queen finds no cells formed ready for the reception of her ova, they retain in their stomachs the honey which they had amassed; and, at the end of 24 hours, the wax oozes out between the rings, when the fabrication of the combs commences. The nursing bees also produce wax, but in a much smaller quantity than the others.

As for the use of the pollen, our authors have ascertained, that it is collected for the purpose of feeding the young; and they have also found, that bees, fed too long on the syrup of sugar alone, are incapable of rearing their offspring, and at length desert the hive. The waxy matter, when newly secreted and moulded in its appropriate organs, differs from real wax in being transparent like scales of talc, white, and quite friable, or brittle; whereas that of which the cells are composed is of a yellowish-white, opaque, and flexible. Our limits will not allow our describing the processes observed by our authors with the aid of a glass apparatus, by which these insects commence and conduct the construction of their combs. The difference of aspect and consistency between cells just formed, and those which are of older standing, cannot fail to attract the attention of every observant apiarian. The former are, in fact, of a dull white colour, semi-transparent, soft, and even, without being smooth; but, in the course of a few days, the whole of their internal surface assumes a yellow tint of greater or less intensity: their sharp edges become thicker and less regular; and those tubes, which at first could not resist the slightest pressure, become flexible, somewhat more heavy, and more difficult of solution in hot water. The contour of the orifice of mature cells is bound with a rim of a reddish and odorous resin, which is also employed to cement the angles of other parts of the cell. This folder or varnish is found, on chemical trial, to be identical with the propolis, and

and quite distinct from the wax. Messrs. Huber have not only established this important fact, but detected the origin of the propolis itself. Having obtained branches of the wild poplar, cut in spring before the development of their leaves, with very large buds filled with viscous, reddish, and odorous juice, they placed these in the way of the bees to the fields, so that they must see them: soon after this arrangement, a bee alighted on one of the branches, and approached one of the largest buds; she then separated its folds with her teeth, attacked the parts which she had half-opened, pulled off filaments of the viscid matter with which they were filled, and then seized, with one of the legs of the second pair, the substance held between her jaws, brought forwards one of her hind-legs, and finally placed in the basket of that leg the little ball of propolis which she had just collected. Having accomplished this object, she again opened the bud in another place, carried off new threads of the same matter with her teeth, laid hold of them with the legs of the second pair, and placed them nicely on the other basket. She then took her departure, and re-joined her hive. In a few minutes afterwards, a second bee alighted on the same branches, and loaded herself with propolis in the same manner. This propolis was found to be different from the matter which imparts the yellow colour to the wax, which is probably secreted in the cavity of the teeth, and deposited on the wax. We observe, however, that bees are not contented with merely painting and varnishing their cells, but they also impart additional solidity to their aggregate amount by the use of a mortar, composed of wax and propolis; and which the ancients, who had not overlooked this department of their economy, termed *metis*, or *pissocerum*. (See PROPOLIS.) With the necessary documents before us, we cannot forbear introducing some further observations on the economy of these insects, though they are not immediately connected with the subject of this article. As the closeness of a hive, and the multitude of living creatures which inhabit it, (amounting sometimes to twenty-five or thirty thousand,) are circumstances which seem to preclude a free ventilation and renewal of air, we might be induced to suppose that bees are not endowed with any particular system of respiratory organs, and that they are capable of existing in any atmosphere, however vitiated. As a test of this supposition, our ingenious and persevering authors recurred to various experiments; which incontrovertibly prove, that these insects cannot long exist either in *vacuo*, or in air that is contaminated by noxious gases; that, in short, they breathe like other animals of their class; and that they are speedily deprived of life if the process of respiration be arrested. Yet it results, from eudiometrical trials, that the air of a well-stocked hive is equally pure with that of the atmosphere. It has been ascertained, too, that neither wax nor pollen favours the production of oxygen gas, and that the bees themselves have no internal faculty of generating vital air; since, if that of the atmosphere be entirely excluded, they are observed to perish in the course of a few hours. Our authors, therefore, took an opportunity of examining, whether the industry of these insects presented no particular cause of this phenomenon; and at length they were struck by the connection which might subsist between the circulation of the air and that beating of the wings which they had recently observed, and which occasioned a continual humming in the interior of their habitation. They suspected that the play of these membranes, which impress the air with sufficient force to elicit from it a very distinct sound, might be destined to replace that which had been vitiated by respiration. Although this may seem to be a trivial cause for counteracting the pernicious effect

above stated, yet by putting the hand near to a fanning-bee, we shall perceive that she agitates the air in a manner that is very sensible, and moves her wings with such rapidity as that they are scarcely distinguishable.

United at their edge by means of small hooks, the two wings of each side present a larger surface to the air, on which they have to strike; they form, besides, a slight concavity, which should somewhat contribute to increase their energy; and we may be satisfied that they describe an arc of 90° , because we see them, simultaneously, on the two extremes of their vibrations. When engaged in this exercise, the bees cling fast to the stand with their legs, the first pair being projected forwards, the second separated and fixed to the right and left of the body, while the third, closely approximated, and in a direction perpendicular to the abdomen, contributes to support the hinder parts in an elevated position. During the fine season, we may always observe a certain number of bees agitating their wings in front of the entrance to their hive; but we may also be convinced, by inspection, that still more of them are employed in fanning within their dwelling. The ordinary station of the ventilating bees is on the lower floor of the hive. All those which are occupied in this way, on the outside, have their heads turned towards the entrance, but those within present their backs to it. These bees seem to arrange themselves methodically, so that they may manage the ventilating process with the greatest ease; being distributed into files, which terminate at the entrance of the hive, and are sometimes disposed like so many diverging rays; but this order is not uniform: and it is probably owing to the necessity to which the fanning bees are subjected of leaving room for such as go and come, whose rapid course constrains them to form in file, that they may avoid being jostled and overturned at every instant. More than 20 bees may sometimes be seen ventilating in the lower part of the hive; but their number at other times is smaller; and each of them vibrates her wings for a longer or shorter period. They have been observed to continue the exertion during 25 minutes, without resting; although they seemed occasionally to take breath by suspending the vibration of their wings for an almost imperceptible instant; but, as soon as they cease from fanning, others take their place, so that the humming noise in a well-filled hive never suffers interruption.

But to return from this digression to the principal subject of the article.

Bees'-wax makes a very considerable article in commerce; the consumption of it throughout the several parts of Europe being incredible. There are two kinds, *white* and *yellow*; the yellow is the native wax, just as it comes out of the hive, after expressing the honey, &c. This colour, says Thorley, is owing to the age of the combs, and breath of the bees; wax, he says, both as it is gathered, and wrought into combs, being always white: the white is the same wax, only purified, washed, and exposed to the air. The preparation of each follows.

WAX, Yellow. To procure the wax from the combs for use; after separating the honey from them as much as possible by the press, they are either soaked for some days in clear water, in order to extract all the honey, or they are broken into pieces, and spread on a sheet near the hives, so that the bees in time suck out all the honey that is left, and reduce the wax into small fragments like bran. Then the whole of the wax is put into a large kettle, with a sufficient quantity of water; and with a moderate fire, it is melted, and then strained through a linen cloth, by a press, and thus freed from all remaining impurity. Before it is cold, they scum it with a tile, or a piece of wet wood, and cast it,

while

while yet warm, in wooden, earthen, or metalline moulds; having first anointed them with honey, oil, or water, to prevent the wax from sticking. Some, to purify it, make use of Roman vitriol, or copperas; but the true secret is to melt, scum it, &c. properly, without any ingredients at all.

The best is that of a high colour, an agreeable smell, somewhat resembling that of honey, soft, somewhat unctuous to the touch, but not sticking to the fingers, nor to the teeth when chewed. When new, it is of a lively yellow colour; it is somewhat tough, yet easy to break; by age, it loses its fine colour, and becomes harder and more brittle. In winter it becomes considerably hard and tough. It is deprived of its yellow colour and smell by exposing it in thin laminæ to the action of the light and air, in the process of bleaching; by which it becomes perfectly white, scentless, somewhat harder, and less greasy to the touch. However, wax is often sophisticated with resin, or pitch, coloured rocou, or turmeric.

The presence of resin may be suspected when the fracture appears smooth and shining, instead of being granulated: and it may be saturated by putting small pieces of the wax into cold alcohol, which will readily dissolve the resinous part, without affecting the wax in any considerable degree.

Its adulteration with earth or peas meal may be suspected when the cake is very brittle, and the colour inclining more to grey than bright pale yellow; and they may be separated by melting and straining the wax. White wax is sometimes adulterated with white oxyd of lead, in order to increase its weight. This may be known by melting the wax in water, when the oxyd falls to the bottom of the vessel.

It is also adulterated by tallow, suet, or any kind of animal fat. It then becomes more fusible, and when rebleached and exposed to a hot sun, it is very apt to cake. It likewise loses its semi-transparency, the distinguishing property of pure bleached wax. This adulteration may be detected by boiling alcohol, which will dissolve wax, but not tallow.

WAX, White. The whitening, blanching, or bleaching of wax, is performed by reducing the yellow sort, first, into little bits or grains, and melting it in a copper cauldron, with water just sufficient to prevent the wax from burning. The cauldron in which the wax is melted is so disposed, that it may flow gradually through a pipe at the bottom into a large tub filled with water, and covered with a thick cloth, to preserve the heat till the water and impurities are settled. From this tub the clear melted wax flows into a vessel, the bottom of which is full of small holes, about the size of a grain of wheat, and hence it falls in small streams upon a cylinder, constantly revolving over water, into which it occasionally dips, so that the wax is cooled, and at the same time drawn out into thin shreds or ribbands. The continual rotation of the cylinder carries off these ribbands as fast as they are formed, and distributes them through the tub. The wax, thus granulated or flatted, is exposed to the air on linen cloths, stretched on large frames, about a foot or two above the ground, in which situation it remains night and day for several days, exposed to the air and sun; and thus the yellow colour nearly disappears. In this half-bleached state, it is heaped up in a solid mass, and allowed to remain for a month or six weeks; after which, to complete the process for whitening it, it is re-melted, and ribbanded, and bleached as before, (in some cases several times) till it wholly loses its colour and smell. Some manufacturers, in re-melting it, add alum or cream of tartar, which are supposed to increase the whiteness and solidity of the wax. Some also, instead of spreading the ribbands of wax on

cloths, lay evenly a broad course of bricks, which are frequently watered, so that the wax is kept from melting by the sun's heat absorbed by the bricks.

When the sun and air have at length perfectly bleached the wax, some melt it for the last time in a large kettle; out of which they cast it, with a ladle, upon a table, covered over with little round dents or cavities, of the form of the cakes of white wax, as sold by the apothecaries, &c. having first wetted those moulds with cold water, that the wax may be the more easily got out. Lastly, they lay out these cakes to the air for two days and two nights, to render it more transparent and dry.

As the volatile sulphureous acid has the property of destroying more quickly almost all the colours of vegetables, it has been suggested by Macquer, the author of the *Chemical Dictionary*, that this bleaching might perhaps be shortened, by exposing ribbands of yellow wax to the vapour of sulphur, as is practised for wool and silk; but this process has not been found to succeed.

However, the operation of bleaching wax above described can be performed well only in fine weather, as it depends chiefly on the action of the sun. This circumstance being attended with much inconvenience to the manufacturers, the discovery of a method of whitening wax independently of the seasons would be very useful, and has been recommended to the attention of chemists by some economical societies.

With a view to discover such a method, Mr. Beckman has made experiments, an account of which is published in the fifth volume of the "*Novi Commentarii Societatis Regiæ Scientiarum Gottingensis*." According to these experiments, thin pieces of yellow wax were whitened and hardened, by being digested and boiled in diluted and undiluted nitrous acid, in a few hours. But the wax thus whitened, being melted by means of boiling water, was observed to acquire a yellow colour, less intense, however, than it was before it had been treated with the mineral acids. The marine and vitriolic acids were less effectual than the nitric or nitro-muriatic. He exposed wax to the flames of burning sulphur, but without success. Yellow wax being melted in vinegar, was rendered of a grey colour. The oil of tartar whitened wax, but less effectually than acids had done; and this wax being washed in water, and afterwards digested in nitrous acid, was rendered still more white; but upon melting it in water, a yellowish tinge returned. He liquefied wax in solutions of nitre and alum, but without any good effect. Spirit of wine, which is recommended by Mr. Boyle for this purpose, did indeed whiten the wax, but changed it to a butyraceous substance, so frothy, that its bulk was increased thirty times. Reflecting that tartar is purified from its oily particles by means of a calcareous earth, he tried the effects of a kind of fuller's earth, which he threw upon wax liquefied in water, and he agitated the mixture. This method rendered wax of a greyish colour, and is, therefore, recommended by him as preparatory to bleaching; the time necessary for which, he thinks, may be thus greatly shortened.

M. Sennebier made some remarks on the effect of light, and other supposed discolouring agents. Some yellow wax was melted, and thinly spread upon a plate of glass; and a similar plate was laid upon it when hot; and the edges of the plates were closed with sealing-wax. Thus the bees'-wax was deprived of the access of air, and it was placed in the sun, to the light of which it was exposed for four or five hours daily. Another quantity of wax was inclosed between plates in a like manner, but kept in the dark. In two days the wax exposed to the sun began to bleach, and in

in a month's time the whole, when it did not exceed one-sixth of an inch in thickness, was quite white; whilst no change at all took place in that which was kept in darkness.

Alcohol has no sensible action on wax when cold, but if the fluid be boiled, it will dissolve rather less than one-twentieth of its weight of wax; and the greater part of it separates, when cold, in the form of white bulky floculi, while the small quantity that remains is wholly precipitated by water. Such is the result of Pearson's and Bostock's experiments; whereas Fourcroy, Chaptal, and Nicholson assert, that it is insoluble in this fluid. Sulphuric ether dissolves wax when heated, and much more copiously than alcohol dissolves it, but the greater part, like that of the former, is separated by cooling, and the remainder by water. Wax boiled in caustic potash makes the fluid turbid, and in process of time rises to the surface in a flocculent form. The portion of the wax, held in solution by the clear alkaline liquor, may be separated by an acid, and the residue floating on the surface is so far converted into a saponaceous state as to have lost its inflammability, and to be no less soluble in pure water than white soap, and again precipitable by acids nearly in its original form, with a restoration of its inflammability. Pure ammonia nearly resembles the fixed alkalis in its action; but the resulting saponaceous form is less soluble in water.

When yellow wax has been long swimming in a solution of carbonate of potash, it becomes grey; and this colour is entirely changed into a milk white by subsequent digestion in nitric acid, and the wax resumes its whiteness.

If wax be distilled with a heat greater than that of boiling water, it may be decomposed. By this distillation, a small quantity of water is first separated from the wax, and then some very volatile and penetrating acid, (probably a modification of the acetous,) accompanied with a small quantity of a very fluid and very odoriferous oil. As the distillation advances, the acid becomes more and more strong, and the oil more and more thick, till its consistence be such, that it becomes solid in the receiver, and is then called *butter of wax*. When the distillation is finished, nothing remains but a small quantity of coal, which is almost incombustible, from the want of some saline matter. Wax cannot be kindled, unless it be previously heated, and reduced into vapours; in which respect it resembles fat oils. The oil and butter of wax may, by repeated distillations, be attenuated, and rendered more and more fluid, because some portion of acid is thereby separated from these substances; which effect is similar to what happens in the distillation of other oils and oily concretes; but this remarkable effect attends the repeated distillation of oil and butter of wax, that they become more and more soluble in spirit of wine; and that they never acquire greater consistence by the evaporation of their more fluid parts. Boerhaave kept butter of wax in a glass vessel open, or carelessly closed, during twenty years, without acquiring a more solid consistence. Wax, its butter, and its oil, differ entirely from essential oils and resins, in all the above-mentioned properties; and in all these perfectly resemble sweet oils. Hence Macquer concludes, that wax only resembles resins in being an oil rendered concrete by an acid; but that it differs essentially from these in the kind of oil, which in resins is of the nature of essential oils; while in wax and other analogous oily concretions, it is of the nature of sweet, unctuous oils, that are not aromatic, and not volatile, and are not obtained from vegetables by expression.

Although wax is not dissoluble at all in watery liquors,

yet the gelatinous solution obtained by boiling it in spirit of wine, by mixture with a thick mucilage of gum arabic, becomes soluble in water, so as to form therewith an emulsion or milky liquor: the wax itself is made in like manner soluble, without the intervention of spirit, by thoroughly mixing it with the gum in fine powder; but when thus dissolved, it proves still insipid, and perfectly void of acrimony.

Wax is soluble abundantly in the fixed oils, and melted with them, produces an uniform mass, the consistence of which, whatever be the proportion of each, is intermediate between the two. It is dissolved but sparingly in essential oils.

Bleached wax burns with a very pure white light, without any offensive smell, and with much less smoke than tallow; and as it is less fusible than tallow, it requires a smaller wick. (See CANDLES.) Bleached wax melts at about 155° of Fahrenheit; and the unbleached at 142° , according to Pearson and Nicholson, and also Dr. Bostock, but at 117° according to Fourcroy; whilst tallow melts at 92° , spermaceti at 133° , adipocire at 127° , and the tallow of the Chinese at 145° . (See Nicholson's Journal, vol. i. p. 70, 4to.) The specific gravity is less than that of water, being about .96.

The yellow wax is brought to market in round cakes about two inches thick; and large quantities of it are imported from the Baltic, the Levant, and the Barbary coast.

The white wax is used in the manufacture of candles, torches, tapers, figures, and a variety of other wax-works. See CANDLES, &c.

It is also an article of the *Materia Medica*, and used as an ingredient, partly for giving the requisite consistence to other ingredients, and partly on account of its own emollient quality, in plasters, cerates, and divers pomatums and unguents for the complexion.

The yellow sort, dissolved into an emulsion, or mixed with spermaceti, oil of almonds, conserve of roses, &c. into the form of an electuary; or divided, by stirring into it, when melted over a gentle fire, as much as it will take up of powdery matter, as the compound crab's-claw powder, has been given also internally, and, as some have pretended, often with great success, in diarrhoeas and dysenteries, for obtunding the acrimony of the humours, supplying the natural mucus of the intestines, and healing their excoriations or erosions.

The empyreumatic oil, into which wax is resolved by distillation with a strong heat, is greatly recommended by Boerhaave and others, for healing chaps and roughness of the skin, for discussing chilblains, and with proper fomentations and exercise, against stiffness of the joints, and contractions of the tendons. It is, without doubt, says Dr. Lewis, highly emollient; but does not appear to have any other quality by which it can act in external applications; it has nothing of the acrimony or pungency which prevail in all the other known distilled vegetable oils; though in smell it is not a little disagreeable and empyreumatic; a circumstance which occasions it to be at present more rarely used than formerly. As the wax swells up greatly in the distillation, it is convenient to divide it, by melting it with twice its weight of sand; or putting the sand above it in the retort, that it may mingle with the wax when brought into fusion. The oil, which is preceded by a small quantity of acid liquor, congeals in the neck of the retort, from whence it may be melted down, by applying a live coal, and made fluid by redistilling it two or three times without addition. The fæces remaining, after expressing the wax, have been used

used both by surgeons and farriers, with success, against frins.

The officinal preparations are as follow: *cera flava purificata* of Dub. Ph.; *oxidum antimonii vitrificatum* *cera* of Edinb.; *emplastrum cereæ* of Lond. and Edinb.; *emplastrum cumini* of Lond.; *empl. picis compositum* of Lond.; *empl. oxidi ferri rubri* of Edinb.; *empl. affa fatidæ* of Edinb.; *empl. gummosum* of Edinb.; *empl. meloes vesicatorii* of Edinb. and Lond.; *empl. galbani* of Dub.; *empl. aromaticum* of Dub.; *ceratum* of Lond. and Dub.; *ceratum calaminæ* of Lond. and Dub.; *ceratum resinæ* of Lond. Edinb. and Dub.; *ceratum sabinae* of Lond. and Dub.; *ceratum saponis* of Lond.; *unguentum picis aridæ* of Lond. and Edinb.; *ung. infusi meloes vesicatorii* of Edinb.; and *ung. cantbaridis* of Dub. Ph. For the first, see *white-wax* below. The second, or vitrified oxyd of antimony with wax, formerly waxed glafs of antimony, is formed by melting one part of yellow wax in an iron vessel, and throwing into it eight parts of oxyd of antimony vitrified with sulphur, reduced to powder, and roasting the mixture with a gentle fire for a quarter of an hour, stirring it assiduously with a spatula; then pouring out the latter, and when cold rubbing it into a powder. This preparation is diaphoretic and cathartic, occasionally exciting nausea and vomiting. It was formerly thought to possess efficacy in diarrhœa and dysentery; but is now scarcely ever prescribed. The dose may be from gr. ij. to gr. xv. given twice or three times a day. For the *empl. cereæ*, see *Wax PLASTER*. For the 4th, see *EMPLASTRUM é Cymino*. For the 5th, see *Compound Pitch PLASTER*. For the 6th, see *PLASTER of red Oxyd of Iron*. For the 7th, see *Affa Fatida PLASTER*. For the 8th, see *Gum PLASTER*. For the 9th, 10th, and 11th, see *PLASTER*. For the others, comprehending *cerates* and *ointments*. See *UNGUENTUM*.

The *bleached* or *white wax* is generally melted and cast, in the manner already stated, into thin discs, about 5 inches in diameter, in which form it is found in the shops. For medical purposes, it is regarded as a demulcent; and has been sometimes administered in obstinate cases of diarrhœa and dysentery, with the view of sheathing the bowels; which effect is better produced by simple mucilages and solutions. It is generally exhibited dissolved in mucilaginous fluids by means of soap, in the proportion of 3d part of the wax, with which it is first melted, and then rubbed in a mortar, with the fluid gradually added; but a preferable method is said to be that of Poerner, which is first to melt the wax with olive oil, and then mix the oily compound while hot with the mucilaginous fluid, by triturating with the yolk of an egg. The dose is a cupfull of the emulsion, containing about ℥j of wax, given every four or five hours. This wax, as well as the yellow sort, is much used in the composition of plasters and ointments. The officinal preparations are *ceratum cetacei* of Lond. Edinb. and Dub. pharmacopeias; *unguentum cetacei* of Lond. and Dub.; *ung. hydrargyri nitrico-oxydi* of Lond.; *linimentum simplex* of Edinb.; and *ung. simplex* of Edinb. See *CERATUM*, *LINIMENT*, and *UNGUENT*. Lewis's Mat. Med.

Yellow wax is made soft with turpentine, yet retains its natural colour. Red wax is only the white melted with turpentine, and reddened with vermilion or alkanet. Verdigrise makes it green; and burnt paper, or lamp-black, black. Some travellers tell us of a natural black wax; assuring us there are bees, both in the East and West Indies, that make an excellent honey, included in black cells. Of this wax, they say, it is, that the Indians make those little vases, in which they gather their balsam of Tolu.

WAX is also produced by the secretion of many plants,

and forms the silvery powder or bloom, which covers their leaves and fruit. It is found very abundantly combined with resin, covering the trunk of the wax-palm (*Cerokylon*) of South America, found in the Quinoliu mountains, 180 feet high, with leaves 20 feet long, the trunk of which is covered with the waxy secretion about two inches thick, and consisting of two-thirds of resin and one of wax; and very pure, encrusting the seeds of the *Myrica cerifera*, or wax-tree of Louisiana, and other parts of North America. The *Pe-la* of the Chinese is an animal wax, and the white lac of India appears to be a variety of wax; so that wax may be regarded, in the extended meaning of the term, both as an animal and a vegetable product. The croton sebiferum, the tomex sebifera, the poplar, the alder, the pine, as well as the Myrica, afford a concrete inflammable matter by decoction, that more or less resembles tallow or wax, that is, a fixed oil saturated with oxygen. But the Myrica cerifera supplies it in the greatest abundance. The grains of this tree, and the shining wax obtained by boiling them in water, have been long ago, viz. in 1722 and 1725, noticed in the History of the Academy of Sciences. The wax, it was observed, is drier and more friable than our's; and it was found, that the liquor in which the grain had been boiled, and from which the wax was procured, afforded, on evaporation, a kind of extract that checked the most obstinate dysenteries; and the inhabitants of Louisiana are said to have made candles of the wax. Several authors have mentioned different species of these trees; but the wax they afford has more lately been the subject of experimental investigation, particularly by M. Cadet and Dr. Bostock. The most fertile of these shrubs afford near seven pounds of berries, the gathering of which employ several families. These berries are thrown into a kettle, and covered with water. Whilst the water is boiling, the grains are stirred about against the sides of the vessel, so that the wax may more easily come off. In a little time it floats on the water like fat, and being collected, is strained through a coarse cloth, to free it from any impurities. This operation is repeated with fresh berries; and when a considerable quantity of wax has been obtained, it is laid upon a cloth to drain off the water; and it is then dried and melted a second time; and when thus purified, formed into masses. Four pounds of berries afford about one of wax: that which is first obtained is generally yellow; but in the latter boilings it assumes a green colour, from the pellicle with which the kernel of the berry is covered. M. Cadet made a variety of experiments on these berries, and found that the powder which was obtained from them afforded an astringent solution by alcohol, and that it contained gallic acid, but no tannin; and to this acid he attributes their effect in dysenteries. The wax, obtained either by the decoction of the grains, or the solution of the powder when precipitated from alcohol by water, when melted, is always of a greenish-yellow; of a firmer consistence than bees'-wax, dry, and sufficiently friable to be pulverized; and evidently more oxygenated than the wax prepared by bees. Candles made of this wax yielded a white flame, a good light, without smoke, and without guttering; and when quite fresh, they emit a balsamic odour, considered in Louisiana as very salutary to persons in bad health. Distilled in a retort, this wax, for the most part, passes over in the form of butter. This portion is much whiter, and has no more consistence than tallow. Another portion that was decomposed afforded a little water, with some empyreumatic oil and sebatic acid. Much carbonated hydrogen gas and carbonic acid gas were disengaged; and there remained in the retort a black and coaly bitumen. Ether was found to dissolve

this wax better than alcohol. Oxygenated muriatic acid rendered this, as well as bees'-wax, perfectly white; but the vegetable wax was bleached with the greatest difficulty. The solution in ammonia is of a brown colour, and a portion of the wax is rendered soapy; and it forms soap with fixed alkali. When the soap of Myrica is decomposed, a very white wax is obtained, but in a state unfit for our uses. Litharge dissolves very well in this melted wax, and forms a hard plaster, the consistence of which may be diminished at pleasure by the addition of a little oil. For bleaching this wax, M. Cadet observes, that two re-agents present themselves to manufacturers, the sulphuric acid and the oxygenated muriatic acid. He proposes the following method as the most speedy in its effect:—Let the wax be reduced to a very divided state, and stratified in a cask with superoxygenated muriate of lime, and let them remain for some time in contact without water. Let the salt be afterwards decomposed with water, acidulated by the sulphuric acid; taking care to pour the water a little at a time at different intervals, until there shall be no longer any perceptible disengagement of muriatic gas; at which period a large quantity of water is to be added, and the mixture agitated with a staff. The insoluble sulphate of lime falls down by repose, while the bleached wax rises and swims at the surface. This is to be washed and melted on the water bath. Our author closes his memoir with recommending the culture of the plant that yields this wax, and with a brief detail of methods for effecting this purpose. Dr. Bostock has also prosecuted an inquiry into the nature and uses of myrtle wax. He finds that in its more important properties it resembles bees'-wax, but that in some respects they differ from one another. The myrtle wax is moderately hard and consistent, possessing in part the tenacity of bees'-wax, without its unctuousity, and also, in some degree, the brittleness of resin. The prevalent colour is pale green, tending in most of the pieces to a dirty grey; in others it is lighter, more transparent, and of a yellowish tinge. Its specific gravity is about 1.0150, water being 1.000, so that it sinks in it, and the white bees'-wax being .9600. Water has no action upon it, either when cold or at the boiling heat. Alcohol, when cold, does not affect it; but 100 parts, by weight, of this fluid, when boiling, dissolve about five parts of the wax. Nearly four-fifths are deposited by the cooling of the alcohol; one-fifth remains suspended, but in the course of a few days is slowly deposited, or may be precipitated by the addition of water. Sulphuric ether, when at the common temperature of the atmosphere, dissolves only a small quantity of this wax, but acts upon it rapidly when boiling. It takes up somewhat more than one-fourth of its own weight. As the ether cools, it is mostly separated, and the small residue may be precipitated by water. After solution, the wax is nearly colourless, and the fluid assumes a beautiful green hue. The deposit by evaporation somewhat resembles spermaceti. Rectified oil of turpentine, at the temperature of the atmosphere, softens the wax, but does not dissolve it: aided by a moderate heat, 100 grains of the turpentine dissolves six grains of the wax. The turpentine acquires a light green tinge, part of the wax is separated as the fluid cools, and part remains permanently dissolved in it. Pure potash renders it colourless by boiling, and forms a soap with a small part, which being decomposed by acid, affords the wax nearly unchanged. Pure ammonia acts nearly as potash, but more feebly. The three principal mineral acids act upon the myrtle wax, but with no great force. The sulphuric acid, with a moderate heat, dissolves about one-twelfth of its weight, and converts it into a thick, dark-brown mass, which on cooling becomes nearly con-

crete, but without any separation of the wax. The nitric and muriatic acids, even when heated, seem to possess little attraction for the wax. From such experiments, Dr. Bostock assigns to myrtle wax, with a considerable degree of probability, the place which it should occupy among chemical substances. Its inflammability, fusibility, insolubility in water, and the action which takes place between it and the alkalies, indicate its affinity to the fixed oils; while its texture and consistence, and more particularly its habitudes with alcohol and ether, manifest a resemblance to the resins. Upon the whole, we may consider the myrtle wax as a fixed vegetable oil, rendered concrete by the addition of a quantity of oxygen; and seeming to hold the same relation to the fixed, which resins do to the essential oils of vegetables. Dr. Bostock has instituted a comparison between myrtle wax and other substances which it resembles, such as bees'-wax, spermaceti, adipocire, and the crystalline matter of biliary calculi; and, upon the whole, deduces this conclusion, that though these five substances possess certain properties in common, and have a degree of similarity in their external appearance, yet that they differ materially in their chemical nature. There is indeed, he says, reason to conjecture, that they are all composed of the same elements, combined together in different proportions, and with different degrees of attraction. Nicholson's Journal, vol. iv. 8vo.

WAX, *Chafe*. See CHAFE.

WAX, *Crude* or *Rough*, called by the French *cire brute*, in *Natural History*, a name given to a substance called by the ancients *erithace*, *fundarac*, and *ambrosia*.

We seem to have no name for it in English, but may call it after the name of the French, *rough wax*.

The Dutch call it the food of the bees, and that, perhaps, very properly, there appearing many reasons to think that the bees eat it.

This is the yellow substance found on the hinder legs of bees in small lumps, of which, as Reaumur and some others erroneously thought, wax is made by this insect. See PAIN *d'Abeilles*.

WAX, *Myrtle*. See MYRICA, and WAX, *supra*.

WAX, *Virgin*, *Propolis*, is a sort of reddish wax, used by the bees to stop up the clefts or holes of the hive. It is applied just as taken out of the hive, without any art, or preparation of boiling, &c. It is the most tenacious of any, and is held good for the nerves. See PROPOLIS.

WAX, *Sealing*, or *Spanish Wax*, is a composition of gum lacca, melted and prepared with resins, and coloured with some suitable pigment.

There are two kinds of sealing-wax in use: the one hard, intended for sealing letters, and other such purposes, where only a thin body can be allowed; the other soft, designed for receiving the impressions of seals of office to charters, patents, and such written instruments.

The best hard red sealing-wax is made by mixing two parts of shell-lac, well powdered, and resin and vermilion, powdered, of each one part, and melting this combined powder over a gentle fire; and when the ingredients seem thoroughly incorporated, working the wax into sticks. Seed-lac may be substituted for the shell-lac; and instead of resin, boiled Venice turpentine may be used. A coarser, hard, red sealing-wax may be made, by mixing two parts of resin, and of shell-lac, vermilion and red-lead, mixed in the proportion of one part of the vermilion to two of the red-lead, of each one part; and proceeding, as in the former preparation. For a cheaper kind, the vermilion may be omitted, and the shell-lac also, for very coarse uses. The hard black sealing-wax may be prepared in the same manner;

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using for the best sort, instead of the vermilion, the best ivory black; and for the coarser sort, instead of the vermilion and red-lead, the common ivory black. For hard green sealing-wax, instead of vermilion, use powdered verdigrise; and for a bright colour, distilled, or crystals of verdigrise. For hard blue sealing-wax, instead of the vermilion, substitute well powdered smalt, or for a light blue, verditer; or a mixture of both. For yellow hard sealing-wax, substitute masticot, or, for a bright colour, turbitth mineral, instead of the vermilion. The hard purple wax is made like the red; changing half the quantity of the vermilion for an equal, or greater proportion of smalt, as the purple is desired to be more blue or more red.

For uncoloured soft sealing-wax, take of bees'-wax, one pound; of turpentine, three ounces; and of olive oil, one ounce; place them in a proper vessel over the fire, and let them boil for some time; and the wax will be then fit to be formed into rolls or cakes for use. For red, black, green, blue, yellow, and purple soft sealing-wax, add to the preceding composition, while boiling, an ounce or more of any ingredients directed above for colouring the hard sealing-wax, and stir the mass, till the colouring ingredient be incorporated with the wax.

The hard sealing-wax is formed into sticks, by rolling the mass on a copper-plate, or stone, with a rolling-board, lined with copper, or block-tin, into rolls of any required size. In order to give them the fire-polish, or gloss, a furnace or stove, like a pail, with bars at the bottom for supporting the charcoal, and notches at the top of the sides for putting the sticks of wax over the fire, is usually provided. By means of this stove the sticks of wax may be conveniently exposed to the fire, and turned about, till the wax is so melted on the surface as to become smooth and shining. Hard sealing-wax may be formed into balls, by putting a proper quantity on the plate or stone, and having fashioned it into a round form, rolling it with the board till it be smooth.

The soft wax is easily formed into rolls or cakes, by pouring the melted mass of the ingredients, as soon as they are duly prepared, into cold water, and working it with the hands into any desired figure. Some perfume both these kinds of wax, by using, for a pound of the wax, half an ounce of benjamin, one scruple of oil of Rhodium, ten grains of musk, and of civet and ambergrise, each five grains; rubbing the oil with the other ingredients powdered; and when the wax is ready to be wrought into sticks, sprinkling in and well stirring the mixture; or by using one ounce of benjamin, one scruple and a half of oil of Rhodium, and five grains of ambergrise, in the same manner. Lewis's Com. of Arts, p. 370. Handmaid to the Arts, vol. ii. p. 34, &c.

WAX-Candles. See CANDLE.

WAX, *To imitate Fruit, &c. in.* Take the fruit, and bury it half-way in clay; oil its edges, and the extant half of the fruit; then nimbly throw on it tempered alabaster, or plaster of Paris, to a considerable thickness. When this is concreted, it makes the half mould, the second half of which may be obtained in the same way. The two parts of the mould being joined together, a little coloured wax, melted, and brought to a due heat, being poured through a hole made in any convenient part of the mould, and presently shook every way therein, will represent the original fruit. Boyle's Works abr. vol. i. p. 136.

Here we must not forget that pretty invention of M. Benoit, a man famous at Paris for his figures of wax. Being by profession a painter, he found the secret of forming moulds on the faces of living persons, even the fairest and most delicate, without any danger either to their health or

complexion: in which moulds he cast masks of wax; to which, by his colours, and glass eyes imitated from nature, he gave a sort of life: inasmuch as, when clothed in proper habits, they bore such a resemblance, that it was difficult distinguishing between the copy and the original.

WAX, *Gilding.* See GILDING.

WAX, *Grafting,* is a composition serving to bind or fix the bud, or graft, in the cleft of the stock.

Instead of grafting wax, the country gardeners, &c. only use clay, over which they lay a piece of linen cloth, and so keep it moist; and to prevent its cracking with the heat of the sun, they tie moss over it. But the wax ordinarily used is a compost of one pound and a half of pitch, a quarter of a pound of wax, and an ounce of oil of almonds, melted and mixed together: with the addition, in spring or autumn, of a moderate quantity of turpentine.

For cleft-grafting, whip-grafting, and grafting by approach, Mr. Mortimer recommends tempered clay, or soft wax; but for rind-grafting, clay and horse-dung.

WAX, *Green.* See GREEN Wax.

WAX, *thorough,* in Botany. See BUPLEURUM.

WAX, *Painting in.* See ENCAUSTIC Painting.

WAX-Bill. See LOXIA *Afrillid.*

WAX-Scot, or Wax-shot, *Ceragium*, in our *Ancient Customs*, money paid twice a year towards the charge of maintaining lights, or candles, in the church.

WAXENBURG, in *Geography*, a town of Austria; 10 miles W. of Freyftadt.

WAXHOLM, a fortress on the coast of Sweden, in the Baltic; situated on a small island at the entrance of the channel of the Malar Lake, and built in the year 1649. It has since been greatly improved and enlarged, so that it has the appearance of a little town. Here all homeward-bound ships are searched. On this island, which is called *Waxon*, besides this fort, are a church, a school, and a custom-house. The chief occupation of the inhabitants is fishing; 16 miles E. of Stockholm. N. lat. 59° 21'. E. long. 18° 16'.

WAXING, *CERATIO*, in *Chemistry*, the preparation of any matter to render it fit and disposed to liquefy, or melt, which of itself it was not.

This is frequently done, to enable things to penetrate into metals, or other solid bodies.

WAXING, in the *Manufacture of Calico*, &c., a process by which the operation of certain colours is resisted by stopping out with wax; but it is too expensive to be often adopted among calico-printers, who are anxious to finish their prints with the least possible charge. Formerly this mode was very generally practised, and great quantities of wax were consumed in the process. In the East Indies wax is still used for preserving the whites in calico-printing. In printing the silk handkerchiefs called bandanas, a process called *waxing* is still followed. It consists in making a preparation of tallow and rosin very liquid by heat, and in printing it in that state with a block upon the silk. When such goods are passed through the blue vat, those parts which are covered with the tallow and rosin are preserved from the action of the indigo, and remain white, while the whole remainder is dyed a fast blue. The method afterwards taken to discharge a part of this blue, and produce yellow, orange, &c. is as follows:—The agent employed for this purpose is the nitrous, and sometimes the nitro-muriatic acid. This was used for the purpose of putting yellow figures upon blue silk handkerchiefs. With this view aqua fortis, or nitro-muriatic acid, of a strength suitable to the kind of blue that is to be discharged, is mixed either with gum-tragacanth, or with flour paste, to a proper consistence, and in this form it is printed on the silk, by means of a common block, on which

the intended pattern is cut. The consequence of this is, that wherever the acid attaches, there the original colour is discharged, and a yellow dye is produced in its place. The pieces are then steamed, by passing them over a vessel containing boiling water, which gives brilliancy to the colour, and finishes the operation. Parkes's Ess. vol. ii. p. 149. 170. See *Discharge Work*, and *DISCHARGING of Colours*.

WAXWAY, in *Geography*, an island in the East Indian sea, near the E. coast of the island of Celebes, about thirty miles in circumference. S. lat. $3^{\circ} 35'$. E. long. $123^{\circ} 15'$.

WAY. See *PULO Way*.

WAY, *Via*. See *HIGHWAY*, *ROAD*, *TURNPIKE*, and *VIA*.

Roman ways are divided into *consular*, *praetorian*, *military*, and *public*. See *VIA*.

We have four notable ones of these in England; anciently called *chimini quatuor*, and intitled to the privileges of *pax regis*. The first is *Wailing-street*, or *Watheling-street*, leading from Dover to London, Dunstable, Towcester, Atterston, and the Severn, near the Wrekin in Shropshire, extending as far as Anglesea in Wales. The second, called *Hekineld*, or *Ikenild-street*, reaches from Southampton, over the river Isis at Newbridge, thence by Camden and Litchfield, then passes the Derwent near Derby, so to Bolsover-castle, and ends at Tinmouth. The third, called *Fosse-way*, because in some places it was never perfected, but lies as a large ditch, leads from Cornwall through Devonshire, by Tetbury near Stow in the Wolds; and beside Coventry to Leicester, Newark, and so to Lincoln. The fourth, called *Erming*, or *Erminage-street*, stretches from St. David's in West Wales, to Southampton.

WAY. See *WEIGH*.

WAY, *Milky*. The opinion, long maintained among astronomers, but lately controverted, that the milky way contains a great number of stars, has been confirmed by the observations of the ingenious and indefatigable Dr. Herschel. On applying his telescope of the Newtonian form, with an object-speculum of twenty feet focal length and an aperture of $18\frac{7}{10}$ inches, to a part of this space, he found that it completely resolved the whole whitish appearance into small stars; which his former telescopes had not light enough to effect. In the tract immediately about the hand and club of Orion, to which his observations were particularly directed, the multitude of stars of all possible sizes that presented themselves to view was astonishing: and in order to form some just idea of their number, Dr. Herschel counted many fields, and computed from a mean of them, what a given portion of the milky way might contain. Among many trials of this sort, he found that six fields, promiscuously taken, contained 110, 60, 70, 90, 70, and 74 stars each. A mean of these gives 79 stars for each field. Hence, by allowing fifteen minutes of a great circle for the diameter of the field of view, it is inferred, that a belt of fifteen degrees in length and two in breadth, which is the quantity often observed by this excellent astronomer to pass through the field of his telescope in one hour's time, could not well contain less than fifty thousand stars, that were large enough to be distinctly numbered. But, besides these, Dr. Herschel suspected at least twice as many more, which, for want of light, he could only see now and then by faint glittering and interrupted glimpses. See *GALAXY* and *NEBULA*.

WAY of a Ship is sometimes used for the same with the *rake*. But the term is more commonly understood of the course or progress which she makes on the water under sail: thus, when she begins her motion, she is said to be *under way*; when that motion increases, she is said to have *fresh way* through the water; when she goes apace, they say *she*

has a good way; and they call the account how fast she sails by the log, *keeping an account of her way*.

And because most ships are apt to sail a little to the leeward of their true course; they always, in casting up the log-board, allow something for her leeward-way. Hence also a ship is said to have *bead-way* and *stern-way*.

WAY of the Rounds, *Chemin des Rondes*, in *Fortification*, is a space left for the passage of the rounds, between the rampart, and the wall of a fortified town.

This is not now much in use; because the parapet not being above a foot thick, it is soon overthrown by the enemy's cannon.

WAY, *Covert*, *Foss*, *Gang*, *Hatch*, *Spur*, and *Water*. See the several articles.

WAY-Bread, in *Agriculture*, a name given in some places to the herb plantain, which is very useful in some grass lands, as increasing the quantity of feed very greatly. See *PLANTAGO*.

WAY-Going Crop, a term applied to that which is taken from the ground the year the tenant or occupant leaves a farm. Such crops are regulated in many different ways, according to the nature of the leases. See *LEASE*.

WAY-Leave, a provincial term for the ground purchased or hired to make a waggon-way upon, between coal-pits and the river.

WAY-Pane, in *Agriculture*, a term applied to the slips left for cartage in watered lands. It is that part of the ground which lies, in a properly watered meadow, on that side of a main where no trenches are formed and taken out, but is floated all the length of the main over its banks, having a drain parallel to it. It serves as a road for conveying the hay upon out of the ground, instead of the teams having to cross all the trenches.

WAY-Thistle, a troublesome plant of the perennial weed kind, with strong roots that branch out in a horizontal manner. Some think it may be weakened or destroyed wholly by frequent cutting over, the best season for which is when it is coming into full bloom; as the wet then gets down its hollow stalk, and aids the rotting of it. In tillage-land it is sometimes got quit of by deep repeated ploughing. See *THISTLE* and *WEEDS*.

WAY-Warden, in *Rural Economy*, a name sometimes given to the surveyor or overlooker of the roads of a district or county.

WAYA, in *Geography*, a town on the E. coast of the island of Celebes, in Tolo bay. S. lat. $1^{\circ} 50'$. E. long. $121^{\circ} 52'$.

WAYAM, a small island in the Pacific ocean, near the S.E. coast of the island of Waygoo. S. lat. $0^{\circ} 24'$. E. long. $131^{\circ} 30'$.

WAYBARI, a river of Guiana, which runs into the Atlantic, N. lat. $6^{\circ} 25'$. W. long. $58^{\circ} 6'$.

WAYBORN HOPE, a creek and point of land, on the N. coast of the county of Norfolk, which takes its name from a village, about five miles from Holt.

WAYED HORSE, in *Rural Economy*, a term applied to an animal of this kind which has been already backed and broken in for work, and which shews a disposition to be tractable and useful. See *HORSE* and *TEAM*.

The term is likewise sometimes applied to team-oxen and other animals.

WAYFARING-TREE. See *VIBURNUM*.

WAYGAT'S STRAIT, in *Geography*, a strait of Russia in Europe, separating a small island, called *Waygat* island, from the continent or country of the Samoiedes. It is also called *Vaigatskoi* and *Vaiatch*. N. lat. 68° . E. long. 60° . See *VAIGATSKOI*.

WAYGOO, an island in the Pacific Ocean, about 60 miles

miles in length, from E. to W., and 25 in breadth. N. lat. $0^{\circ} 2'$ to $0^{\circ} 30'$. E. long. $130^{\circ} 31'$ to $131^{\circ} 40'$.

WAYNE, a town of America, in the district of Maine, and county of Kennebeck, containing 819 inhabitants.—Also, a township of Pennsylvania, in Greene county, containing 588 inhabitants.—Also, a township of Pennsylvania, in Crawford county, containing 502 inhabitants.—Also, a township of Pennsylvania, in Mifflin county, containing 1501 inhabitants.—Also, a county of Pennsylvania, containing 4125 inhabitants.—Also, a township of Ohio, in the county of Adams, containing 901 inhabitants.—Also, a township of Ohio, in the county of Butler, containing 1135 inhabitants.—Also, a township of Ohio, in the county of Columbiana, containing 377 inhabitants.—Also, a township of Ohio, in Jefferson county, containing 1161 inhabitants.—Also, a township of Ohio, in Knox county, containing 478 inhabitants.—Also, a township of Ohio, in Montgomery county, containing 431 inhabitants.—Also, a township of Ohio, in Pickaway county, containing 742 inhabitants.—Also, a township of Ohio, in Scioto county, containing 398 inhabitants.—Also, a township of Ohio, in Tuscarawa county, containing 191 inhabitants.—Also, a township of Ohio, in Warren county, containing 1862 inhabitants.—Also, a county of Kentucky, containing 5393 inhabitants, of whom 226 are slaves; the town Monticilio contains 37 persons, including 4 slaves.—Also, a county of North Carolina, containing 8687 inhabitants, 2756 being slaves.—Also, a county of Georgia, containing 254 inhabitants.—Also, a county of the Mississippi territory, containing 1253 inhabitants, 262 being slaves.—Also, a large township of New York, in the N.E. part of Steuben county, 15 miles E. of Bath, called Frederick's town till the year 1808: it has a post-office called Roscommon. The S. part is hilly, but the central and other parts are arable and productive. The timber is chiefly oak and walnut, and some pine on the hills. Here are a congregation of Baptists, and a competent number of school-houses. The settlement commenced about 1794, and the population is rapidly increasing. In 1810, the number of people was 1025, and that of senatorial electors 57.

WAYNESBOROUGH, a town of Georgia, containing 111 inhabitants.

WAYS and MEANS, *Committee of*. See SUPPLIES.

WAYTE, in *Geography*, a rocky islet in the straits of Macassar, near the west coast of Celebes. S. lat. $0^{\circ} 40'$. E. long. $119^{\circ} 18'$.

WAYTO, a town on the S.E. coast of the isle of Timor. S. lat. $8^{\circ} 30'$. E. long. $126^{\circ} 9'$.

WAY-WISER, an instrument for measuring the road, or distance gone; called also perambulator, and podometer, or pedometer.

Mr. Lovell Edgworth communicated to the Society of Arts, &c. an account of a way-wiser of his invention; for which he obtained a silver medal. This machine consists of a nave, formed of two round flat pieces of wood, one inch thick and eight inches in diameter. In each of these pieces there are cut eleven grooves, five-eighths of an inch wide and three-eighths deep; and when the two pieces are ferewed together, they enclose eleven spokes, forming a wheel of spokes, without a rim: the circumference of the wheel is exactly one pole; and the instrument may be easily taken to pieces, and put up in a small compass. On each of the spokes there is driven a ferril, to prevent them from wearing out; and in the centre of the nave, there is a square hole to receive an axle. Into this hole there is inserted an iron or brass rod, which has the thread of a very fine screw worked upon it from one end to the other; upon this screw

hangs a nut which, as the rod turns round with the wheel, advances or recedes towards or from the nave of the wheel. The nut does this because it is prevented from turning round with the axle, by having its centre of gravity placed at some distance below the rod, so as always to hang perpendicularly like a plummet. Two sides of this screw are filed away flat, and have figures engraved upon them to shew by the progressive motion of the nut, how many circumvolutions the wheel and its axle have made: on one side the divisions of miles, furlongs, and poles, are in a direct, and on the other side the same divisions are placed in a retrograde order.

If the person who uses this machine places it at his right side, holding the axle loosely in his hands, and walks forward, the wheel will revolve, and the nut advance from the extremity of the rod towards the nave of the wheel. When two miles have been measured, the nut will have come close to the wheel. But to continue this measurement, nothing more is necessary than to place the wheel at the left hand of the operator; and the nut will, as he continues his course, recede from the axle-tree, till another space of two miles is measured.

It appears from the construction of this machine, that it operates like circular compasses; and does not, like the common-wheel way-wiser, measure the surface of every stone and mole-hill, &c. but passes over most of the obstacles it meets with, and measures the chords only, instead of the arcs of any curved surfaces upon which it rolls.

WAYWODE. See WAIWODE.

WEACHIN, in *Botany*, the name given by the Indians of America to the maize, or Indian corn, which they cultivated for bread before we knew them.

WEADINGSTEDE, in *Geography*, a town of the duchy of Holstein; 7 miles E. of Wessingburen.

WEAK, or EASY BRANCH, in the *Manege*. See BANQUET, and BANQUET-Line.

WEAK-Land, in *Agriculture*, that which is of a light, thin, open nature, and which is deficient in staple, or the quantity of proper mouldy material. It is directly contrary to that of the cold watery kind, which often changes the nature and quality of the produce, and retards vegetation in the early spring, or during wet seasons, as it forwards the growth of the crops that are put upon it, but is frequently defective in the amount of produce which is afforded. It is to be improved by the use of proper earthy substances and manures, according as the quality of it may be, and by keeping the surface of it as much covered as possible by suitable green crops, to prevent the too great exposure of it to the action of the sun and winds. Such other means, of the same kind, as the nature, circumstances, and situation of the land will permit, may likewise be pursued. See SOIL.

WEAK-Pulse. See PULSE.

WEAKY, in *Agriculture*, a term used to signify juicy, in contradistinction to that of dry or husky, as applied to different kinds of food.

WEALD, or WEALD-Land, a name applied to a kind of wild woody tract of ground of a stiff heavy quality in some southern districts, as those of Kent, Suffex, &c.

It is mostly of a deep tenacious clayey, marly, and loamy nature, but occasionally intermixed with earths of a lighter and more open sort. The writer of the account of the agriculture of the former of the above counties, states, that the weald part of that district was in ancient times an immense wood or forest, inhabited only by herds of deer and hogs, and belonged wholly to the king. That by degrees it became peopled, and interspersed with villages and towns; and by piece-meal, was, for the most part, cleared of its wood, and converted into tillage and pasture. There are, however,

however, some woodlands still in their original state; and by the author of that of the latter, it is remarked, that so predominant is the timber and wood of one sort or another in the weald of that county, that when viewed from any eminence in the neighbourhood, it presents to the eye hardly any other prospect but a mass of wood, which is, it is thought, to be ascribed to the great extent and quantity of wood, preserved by a custom of a nature so extraordinary, that it is not a little surprising no steps have been taken to put an end to it.

When this county was first improved by clearing, as in the other district, it was, it is said, a common practice to leave a *shaw* of wood several yards in width, to encompass each distinct inclosure, as a nursery for the timber and other plants. The sizes of these inclosures being small, they must of necessity contribute to render the general appearance of the tract woody.

Anterior to the Conquest, the weald of this county was, it is said, a continued forest, extending from the borders of the first district to the confines of Hampshire, across the whole of it; and the names of a variety of parishes situated in this line, and evidently derived from Saxon original, attest this fact to the present day. In short, the forest now remaining occupies, it is said, a considerable portion of the county.

The weald parts of both these counties were probably once one great forest.

It is noticed, that there is, perhaps, no object in the weald of the latter county, so worthy of attention and observation as the growth of timber; that there is no region of the earth where trees of all kinds thrive better, but especially those of the oak and ash sorts. The tract there distinguished by the title of the Weald has formerly, it is stated, been covered with trees, and it was called the forest of Anderida; and that now, even if a field be neglected, it will become a wood, principally of oak and birch, intermixed with hazel, some kinds of willow, and dog wood.

This disposition for the growth and raising of wood and timber should, in all cases of weald land where it cannot be converted to a better or more profitable purpose, be taken advantage of and promoted, by proper planting and encouraging the natural growth of the wood thrown up, as it may form one great feature in the improvement of such land, and be productive of vast benefit in bringing every portion and sort of it to the greatest profit.

WEALREAF, in our *Old Writers*, signifies the robbing of a dead man in his grave.

The word comes from the Saxon *weal*, *strages*, and *reaf*, *spoliatio*.

WEANEL, a country term for a young beast newly weaned, or taken from sucking its dam.

WEANING, ABLACTATION. See ABLACTATION.

WEANING *Young Live-Stock*, in *Rural Economy*, the separating them from the mothers in the different kinds, for different purposes, and in different intentions.

Foals, where they are designed for the saddle, should, on being taken from the mothers, be put into some safe sheds or other proper places at a distance, where they can be quiet and out of the hearing of the mares, being well supplied with the necessary sorts of food and good water for a day or two; the buildings should be connected with grass-fields, into which they can be turned in the day-time, but be always brought up for the night, for some time, having proper kinds of dry food then given them in full quantities, so as to get them on well at first. Some intelligent breeders have their young horse-stock fed, after weaning, with coarsely ground oats and one-third flour,

divided into proper feeds, and given on the nights in the houses. This, it is said, pushes them on early to a full growth, and that they never become stunted afterwards. In some instances, it may be useful and proper to put the colt and filly foals into separate pastures. Where a number are to be weaned at a time, it is of advantage to have the pasture-lands pretty large. See BREEDING, FOAL, and HORSE.

In the weaning* of the young of neat cattle, the business is accomplished at different times or ages of the animals, as the nature of the purpose for which they are designed may be; when for rearing as stock, it is often done immediately, or in a few days or weeks, and when for fattening, not at all. If for sale, the time is uncertain, depending on the demand. Where good neat cattle-stock is the object, as soon as the natural food milk is laid aside, a substitute of some good sort of diet should be had recourse to, such as oat or barley-meal, stirred in with the jelly of linseed, that has been produced by being steeped in hot water, and mixed with flat milk; which should be continued until they become capable of eating more firm and solid kinds of food, such as either oats, split beans, and chopped hay, or bran, and barley-flour mixed: in the early spring they should be turned out into good grass pastures in warm situations. By these means they will be brought on well, and become good strong stock. For the purpose of rearing, as well as that of the butcher, those that are dropped early are to be preferred, as after the early spring months, they are not found capable of gaining sufficient strength and hardness before the succeeding winter comes on, or a proper size and growth by the ensuing spring.

In the buying of the young of neat cattle for weaning there are many systems of management among farmers: some prefer bull calves for castration, and which they keep, in some cases, until they become reared, and are fat bullocks fit for the market; others buy cow-calves of the true short-horned, or some other good milking-breed, which they sell at two years, or two years and a half old, and upwards, to the cow-keepers as milking-stock. In this method, they are collected from the latter end of the summer through the autumn of the above true breed, as others will not do from Yorkshire, and other places where they are to be met with of the right kind, as such sell better, and more readily to the cow-keepers for affording milk. In weaning, they are then first put to skim-milk, and tempted as soon as possible to eat some other good food, as bran, oats, oil-cake, the sweetest hay, common turnips, and cole or rape; but nothing is found to do better for them than the Swedish turnip cut small. In keeping them, they should have great attention to cleanliness, and the proper and regular feeding of them. In this way they are continued, being kept in sheds in the night-time, and turned out by day, until the spring, when the ray-grass becomes ready, and then they may go out gradually altogether, according as the weather may be: after ray-grass to the best marshes or pastures; in the autumn to cole or rape that is feeding off for wheat, and after that to turnips: it is a rule with some to feed them through the whole period of keeping them as well as possible. This is expensive, but it is conceived, that if they will not pay for good keeping, they will not for bad. Some, however, when they are turned out, make them the followers of the fattening flock.

In this system there are those, too, who buy both cow and bull-calves, disposing of the former in the above manner, and keeping the latter raising a succession of steers for the grazing or fattening farmers.

All these modes, though hazardous in some instances, are often

often very beneficial. A man is required for the purpose, in autumn, winter, and spring, when the business is carried on upon a large scale. See CALF, BREEDING, and CATTLE. Also COW-KEEPING.

The weaning of lambs is a matter of some trouble and difficulty in many cases; it should be done towards the latter end of the summer, according to circumstances, but never be delayed too long, as the ewes may thereby be greatly hurt in different ways. After the lambs are taken, or lifted as it is sometimes called, from the mothers, they should be allowed to pass the night about the fold or place. In the following morning some of them will begin to eat, and teach the others to do the same. They should then be removed to some convenient soft grassy pasture, disturbing them as little as possible, care being taken that they do not waste or exhaust themselves by running. If there be any danger of their not resting quietly the first night after they are removed, it is said that it may be effectually prevented by pasturing them with their mothers the night immediately preceding their weaning, on their future pasture, and driving them to the fold or other place directly in that road or way by which the lambs are to be removed from it. In the course of ten or twelve days both the lambs and the ewes may be pastured together again without inconvenience. See LAMB and SHEEP.

Store swine should constantly be weaned at the end of a few weeks, as about six or eight, otherwise they do much injury to the sow. The young pigs should be well fed for some time afterwards, in order to push them on to their proper growth, and prevent their becoming dwarfish. The want of attention to this often produces a poor stunted sort of pigs, worth little or nothing. See SWINE.

WEANLING, a term applied in some districts to the newly-weaned calf. See WEANING.

WEAPONS. See ARM and ARMOUR.

WEAPON-Salve, a kind of unguent, supposed to cure wounds sympathetically, by being applied, not to the wound, but to the weapon that made it. See SYMPATHETIC Powder, and TRANSPLANTATION.

WEAR, or WEER, a great flank, or dam in a river; fitted for the taking of fish, or for conveying the stream to the mill. See FISHING, and WEIR.

WEAB, in Geography. See WERE.

WEARE, a township of America, in New Hampshire, in the county of Kellsborough, containing 2634 inhabitants; 18 miles S.W. of Concord.

WEARING, in Sea Language. See VEERING.

WEARY BAY, in Geography, a bay on the N.E. coast of New Holland, S. of Endeavour river.

WEASEL, WEESEL, Common, in Zoology, a species of the mustela. See MUSTELA *Vulgaris*.

The common weasel usually resides in cavities under the roots of trees, as well as of banks near rivulets, &c. from which it occasionally sallies out in search of birds, and more especially of field-mice, great multitudes of which it destroys.

In Norway, Sweden, Russia, and Siberia, the weasel always changes to white at the approach of winter. In Siberia it is called *lasmitka*; and the skins are sold to the Chinese for three or four rubles per hundred.

We have authentic accounts of this animal's being so completely tamed, as to exhibit every mark of attachment to its benefactors, and to be as familiar as a cat or lap-dog. A lady took one of these animals under her protection; and fed it from her hand with warm milk, and also with veal, beef, or mutton. When it is satisfied it generally goes to

sleep, and when it wakes, it amuses itself with various frolics, and bestows the most affectionate caresses on its guardian. It distinguishes the voice of its benefactors amidst twenty people, and gives her a decided preference to all the rest. Among other curious particulars which this lady has recited, we cannot forbear mentioning the curiosity of this animal; it being impossible, as she says, to open a drawer or a box, or even to look at a paper, which this little creature will not also examine. Aldrovandus indeed confirms the account given by Buffon; expressly asserting, that weasels are easily tamed, and that, when tame, they are remarkably playful; adding, at the same time from Curdan, that if their teeth are rubbed with garlick, they will not afterwards presume to bite. This writer also affirms, that the weasel sometimes carries her young in her mouth from place to place several times in a day, when she suspects that they will be stolen from her; resembling some other animals in this respect. For other species of weasel we refer to MUSTELA and VIVERRA; and we shall here add some few species, mentioned by Dr. Shaw, which have not been noticed under either of those articles. Such are the *Viverra Touan*, or ferruginous weasel, white beneath, with the tail naked towards the tip, the "Touan" of Buffon; a native of Cayenne, that lives in hollow trees, and feeds on worms and insects. The *V. Cuja*, or black weasel, with turned up snout, the "Cuja" of Molina, resembling the ferret in shape, manners, and teeth; a native of Chili, and preying upon mice. The *V. Maculata*, or dusky weasel, spotted with white; the "Spotted Martin" of governor Phillips, in its form somewhat resembling the fossane. There are also some other species, not yet sufficiently described, as the grey-headed weasel, or "La Grande Marte de Guiane," of Buffon; the South American weasel, or "La Fouine de la Guiane," of Buffon; the woolly weasel, or "La petite Fouine de la Guiane," of Buffon; the musky weasel of Pennant, a native of Bengal; and the slender-toed weasel with a bushy tail, described, as well as the other, by Mr. Pennant from a drawing; this latter being a native of Cochinchina.

WEASEL-Coot, in Ornithology, the red-headed mew, or *mergus minutus* of Linnæus.

WEATHER, in Agriculture, as denoting the state or disposition of the atmosphere, in regard to heat and cold, drought and moisture, fog, fair, or foul, wind, rain, hail, frost, snow, and other changes, is a sort of knowledge which is of vast utility and importance to the farmer, as the securing of his different produce in a perfect manner greatly depends upon it; and it is in and by means of the atmosphere, that plants are in some measure nourished, and that animals live and breathe: any alterations or changes in its heat, density, purity, or any other respect, must, of course, necessarily be attended with proportionable changes in the state of these.

The great but regular alterations which a little change of weather makes in many parts and sorts of inanimate matter, is fully and strikingly shewn in the common instances and cases of barometers, thermometers, hygrometers, and other such instruments; and it is owing partly to our inattention, and partly to other causes and circumstances, that we, like other animals, do not feel as great and as regular ones in the weight, pressure, and affections, in the tubes, chords, and fibres of our own bodies.

In order, however, fully to form and establish a proper and consistent theory or doctrine of the weather, it would be necessary to have accounts and registers of it regularly and carefully kept, in divers parts of the globe, for a long

series of years, whence, it is possible, we might be enabled to ascertain and determine the directions, breadths, and bounds of the winds, as well as other matters, and the nature of the weather they bring along with them; with the correspondence there may be between the weather of different places, in divers parts of the earth, and the difference between one fort and another at the same place; and thus, in time, learn to judge of, and foretell many great changes and emergencies; such as extraordinary heats, droughts, rains, frosts, snows, and some others. But hitherto very few, and only partial accounts in relation to the weather, have been, for the most part, kept. The general conclusions that have been drawn from the experiments that have been made, and the experience had upon this subject, are, that barometers generally rise and fall together, even at very distant places, and a consequent conformity and similarity of weather; and that this is the more uniformly so, as might be expected, as the places are the nearer together. That the variations of these instruments, too, are the greater, as the places are nearer to the pole; thus, for instance, the quicksilver in them at London, has a greater range by two or three lines than at Paris, and at that place a greater than at Zurich; and that at some places near the equator, there is scarcely any variation at all; that the rain in Switzerland and Italy is much greater in quantity, taking it for the whole year, than in the county of Essex, though the rains are yet more frequent, or there are more rainy days in that county, than in either of the other places; that cold contributes greatly to rain, and this apparently by condensing the suspended vapours, and thereby making them descend; thus, very cold months, or seasons, are very commonly followed immediately by very rainy ones, and cold summers are always wet ones; that high ridges of country, or mountains, such as the Alps and others, and the snows with which they are covered, not only affect the neighbouring places, but even distant countries, as these often partake of their effects; and the weather is mostly rainy in the vicinities of them, both in this and other countries.

The prognostics of the weather that are formed from other circumstances and observations are, that a thick dark sky lasting for some time, without either sun or rain, always becomes fair first and then foul; that is, it changes to a fair clear sky before it turns to rain. The reason is thought to be obviously this: the atmosphere is replete with vapours, which though sufficient to reflect and intercept the sun's rays from us, yet want density to descend, and while these vapours continue in the same state, the weather will do so too: accordingly such weather is commonly attended with moderate warmth, and with little or no wind to disturb the vapours, but having a heavy atmosphere to sustain them; the barometer being commonly high: but when the cold approaches, and by condensing the vapours, drives them into clouds, or drops, the way is made for the sun-beams to display themselves; until the same vapour, by farther condensation, be formed into rain, and fall down in drops. And that a change in the warmth of the weather is often followed by a change in the wind. Thus, the northerly and southerly winds, though commonly accounted the *causes* of cold and warm weather, are in reality the *effects* of the cold or warmth of the atmosphere; of which Dr. Derham assures us he has had so many confirmations, that he makes no doubt of the fact. Thus, it is common to observe a warm southerly wind, suddenly changed to the north, by the fall of snow or hail; or to see the wind in a cold frosty morning north, when the sun has well warmed the air, wheel towards the

south, and again turn northerly or easterly in the cold of the evening.

From the rules laid down by the shepherd of Banbury, many interesting and useful deductions may be made in regard to the weather: it may be concluded, that when the sun rises red and fiery, there will be wind and rain; but that when it rises cloudy, and the clouds soon disappear or lessen, there will certainly be fair weather; and that when the evening is red and the morning grey, a fine day may mostly be predicted.

That when there are small and round clouds, of a dapple grey colour, with a north wind, it may be determined, that there will be fair weather for two or three days; but that large clouds like rocks are a sign of great showers. And that when small clouds increase, it is an indication that there will be much rain; but that if the large clouds are seen to lessen, there will be fair weather. In summer or harvest, it may also be considered, when the wind has been south two or three days and it grows very hot, and clouds are seen to rise with great white tops like towers, as if one were on the top of another, being joined together with black on the lower side, a sign that there will be thunder and rain suddenly. And that when two such clouds rise, one on each hand, it is high time to make haste to shelter.

That when a cloud is seen to rise against the wind, or the side wind, it is a sure sign that when the cloud comes up near you, the wind will blow the way in which the cloud came. It is the same, too, with the motion of a clear place in the sky, when all the parts of it are thick except one edge. That, at all times, when the clouds look black in the west, it is sure to rain; or if raining, it is sure to continue, whatever quarter the wind may be in: and that, on the contrary, if it should break in the west, it is sure to be fair. That fair weather for a week, with a south wind, is likely to produce a great drought.

That the wind usually turns from north to south quietly, but comes back to north strong and with rain. That sudden rains never last long; but that when the air grows thick by degrees, and the sun, or moon and stars, shine dimmer and dimmer, it is likely to rain for some time.

That when it begins to rain from the south with a high wind for two or three hours, and then the wind falls but the rain continues, it is likely to rain twelve hours or more; and that it generally rains until a strong north wind clears the air. But that when it begins to rain an hour or two before sun rising, it is likely to be fair before noon, and to continue so that day; but that if the rain begin an hour or two after sun rising, it is likely to rain all that day, unless the rainbow be seen before it rains.

That when mists rise in low ground and soon disappear, it is a sign that there will be fair weather; but that when they rise to the hill tops, there will be rain in a day or two. That a general mist before the sun rises, when near the time of full moon, is a sign of fair weather. That when there are mists in the new moon, there will be rain in the old; and if there are mists in the old moon, there will be rain in the new. That in regard to the seasons, as spring and summer, when the last eighteen days of the month of February and the first ten days of the following month are for the most part rainy, the spring and summer may be concluded likely to be so too. It is said also, that a great drought has never been known by the writer, but which began at that time. In respect to the winter, when the end of October and the beginning of the following month are, for the most part, warm and rainy, the two beginning months of the new year are likely to be frosty and cold, except after a very

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dry summer. But that when October and the following month are snowy and frosty, the two beginning months of the new year may be likely to be open and mild.

Something may be drawn from the habits, cries, and course of animals, in respect to the weather. It is remarked, that in summer, when sheep rise early in the morning, it is a sure sign of either rain, or a very hot day; and that, in all seasons, when they jump and play much about, it is an indication of rain or wind, but generally of both, in the summer, and of very stormy weather in the winter. That in winter, when the sheep lie under a hedge, and seem loath to go off to pasture, and bleat much, it is considered a sign of a storm. And that, when sheep are fed with hay in the winter, and in frosty and snowy weather they leave the hay, it is a certain sign of the frosts breaking up.

That when rabbits get out to feed early in the morning, it is a sign of rain in the night in summer, and of either rain or snow in winter; and that when it is likely to be a bad night, they will be apt to get home before it is dark.

That pigs appear very uneasy before high winds, and run about squeaking as if they were in great pain.

That when owls screech, it is a certain sign of rain, and mostly in a very short time. Also, that when wood-peckers cry, it is a sign of rain. For this reason, they are called, in some places, rain-fowl. That likewise, when peacocks cry much, it is a sign of rain. That when the cocks begin to crow while it rains, it is a sign of fair weather.

That before a wet summer, the swans build their nests very high; but that before a dry summer they build very low. That the bittern or bitter bump does the same. But that when the raven is observed early in the morning soaring round and round at a great height in the air, it is a sure sign the day will be fine, and that the weather is likely to set in for fair. And that in summer when the bat is seen flying and flitting about very late in the evening, the next day is likely to be fair. That likewise when the swallow is observed to fly high, the weather will most likely be warm and fair. But that when it is noticed to fly low, and dip the tips of its wings in the water as it skims over the surface, the weather is likely to be rainy. And that the continued squalling of the guineez-fowl, and the quacking of ducks and geese, are certain signs of rain.

That before great storms the missel thrush sings particularly loud, and continues to do so until the rain begins. On this account, in some places, it is called the storm-fowl. Also, that in autumn, when flocks of wild geese are seen flying over in a westerly direction, it is a sign there soon will be hard weather. That the early appearance of the wood-cock and field-fare likewise indicate cold hard winters.

That when in the time of hay-making the black snails are to be seen stretched along on the swath of grass, it is a sign of rain. That when frogs look black instead of a golden yellow colour, it is a sign of rain. And the loud hoarse croakings of frogs are sure signs of rain.

That in autumn, when the dor beetle is seen flying about in the evening, the next day is likely to be fine. Also, that when bees do not go out as usual, but keep in their hives, it is a sign of rain. Much information of this nature may be found in Marshall's "Minutes of the Southern Counties," which may be consulted by the cautious farmer with great utility and advantage, in regard to the weather he may have for securing his produce in different cases.

There are other conclusions, too, in respect to the weather, that may be drawn from plants of different kinds, as most vegetables expand their flowers and down in sun-shiny weather; and towards the evening and against rain close them up, especially at the beginning of their flowering,

when the seeds are sensible and tender. This is visible and evident enough in the down of dandelion, and many other downs, and eminently so in the flowers of pimpernel; the opening and shutting of which make what is termed the countryman's *weather-wifer*, by which he foretels the weather of the following day. The rule is, when the flowers are close shut up, it betokens rain and foul weather; but when they are open and abroad fair weather. And lord Bacon observes, that the stalks of trefoil swell against rain, and grow more upright; and that the like may be noticed, though less sensibly, in the stalks of most other plants. It is added, too, that in the stubble fields there is found a small red flower, called by the country people pimpernel, which opening in a morning is a sure indication of a fine day.

"Est & alia (arbor in Tylis) fimilis, foliosior tamen, roseique floris; quem noctu comprimens, aperire incipit folis exortu, meridie expandit. Incolæ dormire eum dicunt. Plin. Nat. Hist. lib. xii. c. 11. See *Sleep of PLANTS*, and *VIGILÆ Florum*.

It is readily conceivable that vegetables should be affected by the same causes as the weather, as they may be considered as so many hygrometers and thermometers, consisting of an infinite number of *tracheæ* or air-vessels, by which they have an immediate communication with the air or atmosphere, and partake of its moisture, heat, and other changes. And hence, too, it is, that all wood, even the hardest and most solid, swells in moist weather, the humid vapours easily insinuating themselves into the pores of it, especially of the lighter and drier kinds, from which they become applicable to many purposes of art, and may tend to shew the change of the weather in some instances.

Hence we derive a very extraordinary use of wood, *viz.* for breaking rocks for mill-stones.

The method at the quarries is this:—Having cut a rock into a cylinder, they divide that into several less cylinders, by making holes at proper distances round the great one; the holes they fill with so many pieces of fallow wood, dried in an oven, which, in moist weather, becoming impregnated with the humid corpuscles of the air, swell; and, like wedges, break or cleave the rock into several stones.

The attentive farmer should store up in his mind as many of the useful rules relating to the weather as possible, as they may serve him very effectually, on many occasions, in the performance of his various business. See *ATMOSPHERE*, *METEOROLOGY*, *HEAT*, *RAIN*, *WIND*, &c.

The members of our Royal Society, the French Academy of Sciences, and many authors of note, have made considerable essays this way; and the practice of keeping meteorological journals has, of late years, become very general. For instructions and examples pertaining to this subject, see Phil. Transf. vol. lxxv. part ii. art. 16.

Eras. Bartholin has observations of the weather for every day throughout the year 1671. Mr. W. Merle made the like at Oxford, for seven years, with a very remarkable care and accuracy. Dr. Plott did the same at the same place, for the year 1684. Mr. Hillier, at Cape Corfe, for the years 1686, 1687. Mr. Hunt, &c. at Gresham college, for the years 1695, 1696. Dr. Derham, at Upminster in Essex, for the years 1691, 1692, 1697, 1698, 1699, 1703, 1704, 1705. Mr. Townley, in Lancashire, in 1697, 1698. Mr. Cunningham, at Emin in China, for the years 1698, 1699, 1700, 1701. Mr. Locke, at Oats in Essex, 1692. Dr. Scheuchzer, at Zurich, in 1708; and Dr. Tilly, at Pifa, the same year. See the Phil. Transactions.

The form of Dr. Derham's observations we give as a specimen of a journal of this kind; observing that he notes

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the strength of the winds, by 0, 1, 2, 3, &c. and the quantity of rain, as it fell through a tunnel, in pounds and centefimals.

Phenomena of the Weather, October 1697.

Day.	Hour.	Weather.	Wind.	Barometer.	Rain.
27	7	Fair.	S.W. 2	29 37	1 52
	12	Rain.	S.W. by W. 5	29 34	
	9	Stormy.	0	29 88	0 29

We have several schemes for keeping meteorological journals or diaries of the weather, extant in the Philosophical Transactions, the Medical Effays of Edinburgh, and in other books. The Ephemerides Ultrajectinæ may also be consulted. The instruments requisite for such journal are, a *Barometer*, *Thermometer*, *Anemoscope*, and *Ombrometer*, which see in their proper places. See a Collection of ingenious observations, and meteorological conjectures, by Dr. Franklin, in his Experiments, &c. p. 182, &c. See EVAPORATION, RAIN, and WIND.

We shall here specify some of the common indications of changes of weather that may be observed at sea. Under the article TIDES we have already stated, that they are raised by the joint actions of the sun and moon; the spring-tides being raised by the sun, and the neap-tides by the difference of the actions of these bodies; and, also, that the spring-tides, near the time of an equinox, are higher than at other times of the year. Now, since the atmosphere is a fluid much lighter than water, it must, therefore, be more affected about the times of new and full moon, and in the months of March and September, than at other times. This is confirmed by observation; for, about the times of new and full moon, an alteration in the state of the weather usually happens; and the violent gales about the time of the equinoxes, called *equinoxial gales*, are well known, and expected by every seaman.

According as the state of the atmosphere is more or less disturbed, it is evident the appearance of the heavenly bodies will be more or less altered. Thus, if the moon appears paler than usual, or if there is a halo about the moon, rain will probably follow soon after. Several circles about the moon portend wind. These observations are also applicable to the sun. If the moon appears of a red colour, or if the moon's horns are blunt, they are signs of wind, which may be expected from that quarter to which the bluntest horn is directed. In viewing the moon with a telescope in a quiet evening, if one part of the moon's limb be observed to be tremulous, while the opposite part of the limb is without the least apparent tremor, the wind may be expected from that point to which the limb free of tremors is directed. A red circle about the moon towards the time of full moon indicates wind.

One of the best known signs in the heavens is the *Rain-bow*; which see. When the blue and yellow parts of the rainbow are very bright, or if all of it vanish at the same time, it will be fair weather: if the bow appears to be broken in several places, tempestuous weather may be expected.

From the various appearances of the clouds, (see CLOUD,) which are vapours floating in the atmosphere, producing rain, hail, snow, thunder, and lightning, the approaching weather may, in some measure, be predicted. The height of the clouds seldom exceeds a mile; and the summits of high mountains are free of clouds.

When the sky is of a fine blue colour, without any clouds,

it will continue to be fair weather; but if it is of a very dark blue, clouds will be formed, and rain, wind, or fog, will soon follow.

When the sky appears very much clouded for some time, without rain, it generally first clears up, and then changes to rain. This is accounted for as follows:—The atmosphere at that time being replete with vapours, which, though sufficient to intercept the rays of the sun, yet want density to descend; and while the vapours continue in the same state, the weather will do so too; and such weather is commonly attended with moderate warmth, and with little or no wind to disturb the vapours, and an heavy atmosphere to support them, the barometer being commonly high. But when the cold approacheth, and, by condensing the vapours, drives them into clouds or drops, then way is made for the sun-beams, till the same vapours, by farther condensation, be formed into rain, and fall down in drops.

If the clouds, in a summer evening, gradually diminish, and at last vanish, it will be fine weather; but, if they increase, and small clouds be observed to move very swiftly underneath, it will be rain soon after; or, if the clouds change to a dark colour, thunder may be expected.

If the clouds in the western hemisphere, at the time of sun-set, are tinged with a light red and yellow; or, if there are no clouds, and the sky, towards that part of the horizon where the sun sets, be of a beautiful red and yellow, it will be fine weather: but if the sun be of a pale colour, or if the clouds change to a dark red, and continue, it will be rain. The clouds tinged with a dark red in the opposite hemisphere to the sun, whether at rising or setting, presage wind.

In winter, when large clouds are observed with white edges, and a strong blue sky above them, it will be hail or snow; or probably these may be dissolved into rain before they reach the earth.

When there are two or more strata of clouds moving in different directions, rain generally follows. Many small clouds pretty high, and other appearing at the same time in form of fleeces of wool, denote wind.

A cloud of an oblong form, sometimes called *Noah's Ark*, seen in a clear sky, and changing from a fine light to a dark colour, is a sign of rain; but, if it changes from dark to light, it is a sign of fair weather.

A small black cloud seen in a clear sky, or several small clouds collecting near each other, are an indication of wind from the quarter from whence they are observed to move: also, if the clouds are observed to diverge from a point in the horizon, wind may be expected from that, or from the opposite point.

When stars of the second and third magnitudes are suddenly obscured, wind or rain will soon follow. Those meteors, commonly called *falling* or *shooting* stars, are usually the forerunners of wind.

That appearance in the heavens resembling a portion of the rainbow, but apparently broader than any part of the arch when complete, and generally known by the name of a *Wind-gall*, is an indication of an approaching gale.

The *Aurora Borealis*, (which see,) or northern light, is a sign of wind from between the S. and S.W. points, attended with hazy weather, and small rain, the gale generally commencing between twenty-four and thirty hours after the first appearance of the aurora. The violence of the gale, and the time of its commencement after the aurora borealis is seen, and duration, depend, in a great measure, upon the brightness and motion of the aurora; for the more brilliant the aurora, and the quicker its motions, the gale will happen sooner, be more violent, and of shorter duration.

A change

A change in the wind commonly produces a change in the weather. Thus, in fair weather, if the wind changes to the opposite point, rain may be expected: but, in rainy or foggy weather, it will clear up soon after the change of the wind.

In a storm at sea, a fiery meteor, in form of a ball, affording an obscure flame like a candle burning faintly, is sometimes seen adhering to the masts, yards, &c. or leaping from one part to another. When only one is seen, it is called *Helena*, and is a sign that the severest part of the storm is yet to come. When two are observed, they are called *Castor* and *Pallux*, and sometimes *Tyndarida*, and denote the storm to be near an end. If five of these balls are seen together, which the Portuguese call the *Virgin Mary's Crown*, it is considered to be a sure sign that the storm will be soon over. When the meteor adheres to the masts, yards, &c. it is concluded, from the air not having sufficient motion to dissipate the flame, that a calm will soon ensue; but if it leaps from one place to another, that it denotes a storm.

At the Cape of Good Hope, an approaching storm, or gale of wind, is easily known by the following observations:—When a small black cloud, called the *Ox-eye*, is observed to rise from the top of Table Mountain, which continues to increase until the heavens be almost entirely overclouded, the storm then commences. A similar phenomenon usually precedes a storm at the Arabian gulf: this storm comes from the north, and is accompanied with a great quantity of red sand.

When a hurricane happens in the West Indies, it is generally either at new or full moon, or at the quarters, and the signs are as follow:—The sun and moon appear redder than usual, and are sometimes surrounded with a halo; the stars at night appear larger and fainter; the sky in the N.W. quarter is dark; the hills are clear of those clouds and mists which usually hover about them; the sea emits a strong smell, and is violently agitated, often when there is no wind; the wind also veers about to the west, from whence it sometimes blows with intermissions violently and irregularly for about two hours at a time.

The tumbling of porpoises indicates a gale of wind. When a swell sets from any particular point, there being no wind, a gale may be soon expected from that point.

From a very great number of meteorological observations, made in England between the years 1677 and 1789, Mr. Kirwan has deduced the following probable conjectures of the weather:

1. That when there has been no storm before or after the vernal equinox, the ensuing summer is generally *dry*, at least five times in six.
2. That when a storm happens from any easterly point, either on the 19th, 20th, or 21st of March, the succeeding summer is generally *dry*, four times in five.
3. That when a storm arises on the 25th, 26th, or 27th of March, and not before, in any point, the succeeding summer is generally *dry*, four times in five.
4. If there be a storm at S.W. or W.S.W. on the 19th, 20th, 21st, or 22d of March, the succeeding summer is generally *wet*, four times in five.

We shall further subjoin the following observations:

1. A moist autumn, with a mild winter, is generally followed by a cold and dry spring, which greatly retards vegetation.
2. If the summer be remarkably rainy, it is probable that the ensuing winter will be severe; for the unusual evaporation will have carried off the heat of the earth. Wet summers are generally attended with an unusual quantity of

feed on the white thorn and dog-rose bushes. Hence, the unusual fruitfulness of these shrubs is a sign of a severe winter.

3. The appearance of cranes, and birds of passage, early in autumn, announces a very severe winter; for it is a sign that it has already begun in the northern countries.

4. When it rains plentifully in May, it will rain but little in September, and *vice versa*.

5. When the wind is S.W. during summer or autumn, and the temperature of the air unusually cold for the season, both to the feeling and the thermometer, with a low barometer, much rain is to be expected.

6. Violent temperatures, as storms or great rains, produce a sort of crisis in the atmosphere, which produces a constant temperature, good or bad, for some months.

7. A rainy winter predicts a sterile year; a severe autumn announces a windy winter.

For indications of the weather by the barometer, see BAROMETER. By the *Thermometer*, (which see,) Mr. Dalton deduces the following conclusions:

The mean altitude of the mercury in the thermometer in Britain is about 55° : if higher, the weather is warm; but if lower, it is cold.

A quick and considerable alteration in the altitude of the mercury in the thermometer indicates rain.

If it begins to snow when the thermometer is below 32° , the mercury generally rises to that altitude, and continues while the snow falls. If the weather clears up soon after, a severe cold may be expected. See also HYGROMETER, from which it is inferred, that, when the index of the hygrometer points to *dry*, and continues proceeding towards extreme dryness, fair weather, and probably wind, may be expected; but if the index returns to the mean state, it will be rain. If the index points to *moist and increasing*, rain will soon follow; if it returns towards the mean, it will be fair weather.

As to the supposed influence of the moon upon the weather, see *Influence of the Moon*.

WEATHER, in *Sea Language*, is used as an adjective, and applied by mariners to every thing lying to windward of a particular situation: thus, a ship is said to have the weather-gage of another, when she is farther to windward. Thus also, when a ship under sail presents either of her sides to the wind, it is then called the weather-side, or weather-board; and all the rigging and furniture situated on it are distinguished by the same epithet; as the weather-shrouds, the weather-lifts, the weather-braces, &c.

To WEATHER, is to sail to windward of some ship, bank, or head-land.

WEATHER-Beaten. Scattered by a storm.

WEATHER-Bit, denotes a turn of the cable of a ship about the end of the windlafs, without the knight-heads. It is used to check the cable, in order to slacken it gradually out of the ship, in tempestuous weather, or when the ship rides in a strong current. See RING-Ropes.

WEATHER-Boarding, among *Carpenters*, &c. denotes the nailing up of boards against a wall, and sometimes the boards themselves when thus nailed up.

WEATHER-Cock, or *Weather-Vane*, a moveable vane, in form of a cock, or of other shape, placed on high, to be turned round according to the direction of the wind, and point out what quarter the wind blows from. See VANE.

WEATHER-Cord. See HYGROMETER.

WEATHER, *Hard-a*. See HARD.

WEATHER-House. See HYGROMETER.

WEATHER-Gage, in *Sea Language*. When a ship or fleet is to windward of another, she is said to have the weather-gage of her.

WEATHER-Glasses are instruments contrived to indicate the state or disposition of the atmosphere, as to heat, cold, gravity, moisture, &c. to measure the changes befalling it in those respects; and by those means to predict the alteration of weather, as rains, winds, snow, &c.

Under the class of weather-glasses, are comprehended *barometers, thermometers, hygrometers, manometers, and anemometers*, of each of which there are divers kinds. See their theories, constructions, uses, kinds, &c. under **BAROMETER, THERMOMETER, HYGROMETER, &c.**

WEATHER-Quarter, in *Sea Language*, that quarter of the ship which is on the windward side.

WEATHER-Quoil or *Coile*, is the turning of the ship's head about, so as to lie that way which her stern did before without loosing any sail, but only by bearing up the helm.

WEATHER-Side, the side of a ship upon which the wind blows.

WEATHER-Shore, a name given to the shore lying to windward.

WEATHER-Tiling, in *Building*, the covering of the upright side of a house with tiles.

WEATHERER, in *Geography*, one of the smaller Shetland islands. N. lat. 60° 35'. W. long. 1° 13'.

WEATHERING, a doubling, or failing by a point, or place.

WEATHERING, among *Mill-wrights*. See **WIND-Mill**.

The WEATHERING of a Hawk, among *Falconers*, is the setting of her abroad to take the air.

WEATHERSFIELD, in *Geography*, a town of the state of Connecticut, in the county of Hartford, founded about the year 1639, containing 2868 inhabitants; 5 miles S. of Hartford.—Also, a township of Vermont, in the county of Windfor, containing 2115 inhabitants; 3 miles S. of Windfor.—Also, a town of Ohio, in the county of Trumbull, containing 232 inhabitants.

WEAVER, in *Manufactures*, one who practises the art of weaving.

Persons using the trade of a weaver, shall not keep a tucking or fulling-mill, or use dyeing, &c. or have above two looms in a house in any corporation or market-town, on pain of forfeiting 20s. a week: and shall serve an apprenticeship for seven years to a weaver or clothier, or shall shall forfeit 20l. &c. 2 & 3 Ph. & M.

WEAVER's Alarm. This contrivance is only a weight fastened to a packthread, which is placed horizontally, so that in a certain time a candle may burn down to it. Then the flame of the candle setting fire to the thread, the weight falls, and awakens the sleeping person. See *Phil. Trans.* No. 477. sect. 14, where we have a figure to explain the invention, which has got its name from being in frequent use among the weavers.

WEAVER's Lake, in *Geography*, a lake of New York; 3 miles N.W. of Otsego lake.

WEAVING, in *Manufactures*, is the art of combining and uniting threads together, to form cloth. *Stocking-knitting* or weaving is a distinct art from cloth-weaving, the manner of combining the thread, being essentially different in the two. In the stocking fabric, the whole piece consists of one continuous thread, which is formed into a series of loops in successive rows; and the loops of each row are drawn through the loops of a former row. See **STOCKING-Frame**.

Woven cloth is always composed of two distinct systems

of threads, called the warp and the weft: these traverse the piece of cloth in opposite directions, and are usually at right angles to each other. Those threads, (or, as the weavers call them, yarns,) which run in the direction of the length of the web or piece of cloth, are called the warp, and they extend entirely from one end of the piece to the other. The cross thread, or yarn, runs across the cloth, and is called the woof or weft. This is in fact one continued thread through the whole piece of cloth, being woven alternately over and under each yarn of the warp, which it crosses, until it arrives at the outside one. It then passes round that yarn, and returns back over and under each thread, as before; but in such a manner, that it now goes over those yarns which it passed under before, and *vice versa*; thus firmly knitting or weaving the warp together. The outside yarn of the warp, round which the woof is doubled, is called the selvage, and cannot be unravelled without breaking the weft. The strength of the cloth, in the direction of the length, must depend on the threads of the warp; but its strength in the opposite direction will depend upon the weft; and the strength of these two threads should be always properly proportioned to each other.

The combined arts of spinning and weaving are among the first essentials of civilized society, and we find both to be of very ancient origin. The fabulous story of Penelope's web, and, still more, the frequent allusions to this art in the sacred writings, tend to shew, that the fabrication of cloth from threads, hair, &c. is a very ancient invention. It has, however, like other useful arts, undergone a vast succession of improvements, both as to the preparation of the materials of which cloth is made, and the apparatus necessary in its construction, as well as in the particular modes of operation by the artist. Weaving, when reduced to its original principle, is nothing more than the interlacing of the weft or cross threads into the parallel threads of the warp, so as to tie them together, and form a web or piece of cloth. This art is doubtless more ancient than that of spinning, and the first cloth was what we now call matting, *i. e.* made by weaving together the shreds of the bark, or fibrous parts of plants, or the stalks, such as rushes and straws.

This is still the substitute for cloth amongst most rude and savage nations. When they have advanced a step farther in civilization than the state of hunters, the skins of animals become scarce, and they require some more artificial substance for clothing, and which they can procure in greater quantities. Nevertheless, some people are still ignorant of the art of weaving; for the cloth made in the islands of the South sea appears to be made by cementing or glueing the shreds together, rather than by weaving. From the description given by captain Cook, and other circumnavigators, and from the specimens which have been brought to Europe, their cloth, or rather matting, is in general produced by cohesion of the parts, rather than texture. This assimilates it more to the ideas which we attach to paper, or pasteboard, than to those which we form of cloth.

When it was discovered that the delicate and short fibres, which animals and vegetables afford, could be so firmly united together by twisting, as to form threads of any required length and strength, the weaving art was placed on a permanent foundation. By the process of spinning, which was very simple in the origin, the weaver is furnished with threads far superior to any natural vegetable fibres in lightness, strength, and flexibility; and he has only to combine them together in the most advantageous manner.

The art of weaving cloth has been so extensively applied

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in almost every civilized country, and the knowledge of its various branches has been derived from such a variety of sources, that no one person can ever be practically employed in all its branches; and though every part bears a strong analogy to the rest, yet a minute knowledge of each of these parts can only be acquired by experience and reflection. We will endeavour to give the reader as comprehensive an idea of the history and progress of this ancient and invaluable art as the nature of the thing, and the limits to which we are necessarily confined, will permit.

The history of this art is very little known, and its great antiquity necessarily involves the earlier eras of it in the most perfect obscurity.

The art of making linen, which was probably the first species of cloth invented, was communicated by the Egyptians, the inhabitants of Palestine, and other eastern nations, to the Europeans. By slow degrees it found its way into Italy; and it afterwards prevailed in Spain, Gaul, Germany, and Britain. The Belgæ manufactured linen on the continent; and when they afterwards settled in this island, it is probable they continued the practice, and taught it to the people among whom they resided.

When it is considered that the wants of mankind are nearly the same in all countries, it is not improbable that the same arts, however varied in their operations, may have been separately invented in different countries. It is not, however, certain that the art of making cloth is one which the Britons invented for themselves.

It is most probable that the Gauls learned it from the Greeks, and communicated the knowledge of it to the people of Britain. It is very certain that the inhabitants of the southern parts of Britain were well acquainted with the arts of dressing, spinning, and weaving, both flax and wool, when they were invaded by the Romans. Nevertheless, we have the authority of Julius Cæsar, that when he invaded Britain, the art of weaving was totally unknown to the Britons.

Whatever knowledge the Britons might possess of the clothing arts, prior to the invasion, it is very certain that these arts were much improved amongst them after that event. It appears from the *Notitia Imperii*, that there was an imperial manufactory of woollen and linen cloth, for the use of the Roman army then in Britain, established at *Venta Belgarum*, now called Winchester.

Many public acts relative to the woollen manufacture, in the earlier period of English history, evidently prove that the greater part of our wool was, for a very long series of years, exported in a raw state, and manufactured upon the continent.

In bishop Aldhelm's book concerning "Virginity," written about A.D. 680, it is remarked, "that chastity alone forms not a perfect character, but requires to be accompanied and beautified by other virtues." This observation is illustrated by the following simile, borrowed from the art of figure-weaving: "It is not a web of one uniform colour and texture, without any variety of figures, that pleaseth the eye, and appeareth beautiful; but one that is woven by shuttles, filled with threads of purple, and many other colours, flying from side to side, and forming a variety of figures and images, in different compartments, with admirable art."

Perhaps the most curious specimen of this ancient figure-weaving and embroidery, now to be found, is that preserved in the cathedral of Bayeux. It is a piece of linen, about 19 inches in breadth, and 67 yards in length, and contains the history of the Conquest of England by William

of Normandy; beginning with Harold's embassy, A.D. 1065, and ending with his death at the battle of Hastings, A.D. 1066. This curious work is supposed to have been executed by Matilda, wife to William, duke of Normandy, afterwards king of England, and the ladies of her court. Although it is certain that the art of figure-weaving was then known in Britain, it must be owned, that the piece of tapestry just mentioned owes most of its beauty to the exquisite needle-work with which it is adorned.

The silk manufacture was first practised in China, and the cotton in India. Both the woollen and linen were borrowed by the English from the continent of Europe; and for many ages, all the improvements in them in this country were first introduced into this country by foreign artificers, who settled amongst us.

About the close of the eleventh century, the clothing arts had acquired a considerable degree of improvement in this island. About that time, the weavers in all the great towns were formed into guilds or corporations, and had various privileges bestowed upon them by royal charters.

In the reign of Richard I., the woollen manufacture became the subject of legislation; and a law was made, A.D. 1197, for regulating the fabrication and sale of cloth.

The number of weavers, however, was comparatively small, until the policy of the wise and liberal Edward III. encouraged the art, by the most advantageous offers of reward and encouragement to foreign cloth-workers and weavers, who would come and settle in England. In the year 1331, two weavers came from Brabant, and settled at York.

The superior skill and dexterity of these men, who communicated their knowledge to others, soon manifested itself in the improvement and spread of the art of weaving in this island.

Many Flemish weavers were driven from their native country, by the cruel persecutions of the duke d'Alva, in the year 1567. They settled in different parts of England, and introduced or promoted the manufacture of baizes, serges, crapes, and other woollen stuffs.

About the year 1686, nearly 50,000 manufacturers, of various descriptions, took refuge in Britain, in consequence of the revocation of the edict of Nantz, and other acts of religious persecution committed by Louis XIV. These improvements chiefly related to silk-weaving.

The arts of spinning, throwing, and weaving silk, were brought into England about the middle of the 15th century, and were practised by a company of women in London, called silk-women. About A. D. 1480, men began to engage in the silk manufacture, and the art of silk-weaving in England soon arrived at very great perfection. See **SILK**.

The civil dissensions which followed this period, retarded the progress of these arts; but afterwards, when the nation was at rest, the arts of peace, and among others that of weaving, made rapid advances in almost every part of the kingdom.

In the latter part of the last century, the invaluable inventions of sir Richard Arkwright, introduced the very extensive manufacture of cotton, and added a lucrative and elegant branch of traffic to the commerce of Britain. The light and fanciful department of the cotton manufacture has become, in some measure, the staple manufacture of Scotland, whilst the more substantial and durable cotton fabrics have given to England a manufacture inferior, in importance and extent, only to the woollen trade.

At the present day, our superiority in point of quality is

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is universally acknowledged in the cotton manufacture ; but in those of silk, linen, and woollen, it is still disputed by other countries.

Loom.—Weaving is performed by the aid of a machine called a loom. The common loom for plain cloth is a very simple machine ; but some of the varieties which are used for weaving ornamental and figured cloth are very curious : still there are parts common to all. The principal of these are as follows.

1. The yarn-beam, which is a round wooden roller, on which is wound or rolled the warp, or yarns that are to form the length of the piece of cloth.
2. The cloth-beam is a similar roller, on which the cloth is rolled up when woven. The yarns of the warp are extended in parallel lines, between the yarn-roll and the cloth-roll, so as to form a horizontal plane, or sheet, and are combined together by the cross-threads, or weft.
3. The shuttle, which has a hollow to contain a bobbin or pirn of the weft.
4. The heddles, which are threads with loops or eyes, through which the yarns of the warp pass : the heddles are connected with the treadles, upon which the weaver places his feet, to draw down one set of heddles and raise up another, so as to open and separate the warp into two divisions, and allow a passage, called the shed, for the shuttle between them.
5. The reed, which is a frame containing a row of parallel shreds of reeds or cane, and the yarns of the warp pass between them, as it were between the teeth of a comb.
6. The reed is fixed in a frame, called the lay or lathe, which swings upon centres of motion. The use of the reed and lay is to comb or push the threads of the weft close to each other, and make the cloth close and dense.

The operation of weaving or working the loom for plain cloth consists of three very simple movements, *viz.* 1. Opening the shed in the warp alternately, by pressing the two treadles with his feet in opposite directions. 2. Driving or throwing the shuttle through the shed when opened. This is performed by the right-hand, when the fly-shuttle is used, and by the right and left alternately, in the common operation, wherein the shuttle is thrown from one hand and caught in the other. 3. Pulling forward the lay or batten to strike home the woof, and again pushing it back nearly to the heddles. This is done by the left-hand with the fly-shuttle, or by each hand successively in the old way.

There are several different ways of setting up a loom for weaving plain cloth ; but the principal parts are always made the same. We shall first describe that which is used for weaving plain silks : it is shewn in perspective in *Plate II. Weaving.* In this *A* is the yarn-roll or beam, on which the thread to form the warp is regularly wound ; *B*, the cloth-beam, or breast-roll, on which the finished cloth is wound up ; *D E*, the treadles, on which the weaver presses his feet ; *dd, ee*, are the heddles, or harness. These are each composed of two small rods *dd* and *ee*, connected together by several threads, forming a system of threads, which is called a heddle ; *ee* is another heddle, behind the former. In the middle of each thread of the heddle is a loop, through which a yarn of the warp is passed, every other yarn going through the loops of the heddle *ee*, and the intermediate yarns passing between the threads of that heddle, and afterwards through the eyes or loops of the other heddle *dd*.

The two heddles, *dd* and *ee*, are connected together by two small cords going over pulleys, suspended from the top of the loom, so that when one heddle is drawn down, the other will be raised up. The heddles receive their

motion from the levers or treadles *D E*, moved by the weaver's feet. The yarns of the warp being passed alternately through the loops of the two heddles, by pressing down one treadle, as *E*, all the yarns belonging to the heddle *ee* are drawn down ; and by means of the cords and pulleys, the other heddle *dd*, with all the yarns belonging to it, are raised up ; leaving a space, called the shed, of about two inches between the yarns, for the passage of the shuttle.

F, G G, H, (*fig. 2.*) is a frame, called the batten or lay, suspended by the bar *F*, from the upper rails of the loom, so that it can swing backwards and forwards, as on a centre of motion ; the bottom bar *H* is much broader than the rails *G G*, and projects before the plane about an inch and a half, forming a shelf, called the shuttle-race. The ends of the shuttle-race *H* have boards nailed on each side, to form two short troughs or boxes *I I*, in which pieces of wood or thick leather *kk*, called peckers or drivers, traverse. The peckers are guided by two small wires, fixed at one end to the uprights *G G*, and at the other to the end-pieces of the troughs *I I*. Each pecker has a string fastened to it, tied to the handle *y*, which the weaver holds in his right-hand when at work, and with which he pulls, or rather snatches, each pecker either to the right or left alternately.

R is the reed : it is a small frame, fixed upon a shuttle-race *H*, containing a number of small pieces of split reeds or canes ; or else of pieces of flat wire, of steel or brass ; but the cane is most common, although the frame is called the reed. When *fig. 2.* is in its place in the loom, the yarns of the warp pass between the canes or dents of the reed. In *fig. 2.* the reed is represented without the top or piece which covers it, and which is called the lay-cap. It is a rail of wood with a longitudinal groove along its lowermost side, for the purpose of sustaining the upper edge of the reed. The lay-cap is that part of the machine on the middle of which the weaver lays hold with his left-hand when in the act of weaving.

The shuttle (*see Plate I.*) is a small piece of wood pointed at each end, from three to six inches long. It has an oblong mortise in it, containing a small bobbin or pirn, on which is wound the yarn which is to form the weft ; and the end of this yarn runs through a small hole in the shuttle, called the eye. The shuttle has two little wheels on the under side, by which it runs easily upon the shuttle-race *H*.

Operation.—The weaver sits on the seat *M*, (*fig. 1.*) which hangs by pivots at its ends, that it may adapt itself to the ease of the weaver when he sits upon it. It is lifted out when the weaver gets into the loom, and he puts it in again after him. He leans lightly against the cloth-roll *B*, and places his feet upon the treadles *D E*. In his right-hand he holds the handle *y* (*fig. 2.*), and by his left he lays hold of the rail, called the lay-cap, which crosses the batten or lay *G G*, and serves to support the upper edge of the reed *R*. He commences the operations by pressing down one of the treadles with his foot : this depresses one-half of the yarns of the warp, and raises the other, as before-described. The shuttle is previously placed in one of the troughs *I*, against the pecker *K*, belonging to that trough. By the handle of the pecker, with a sudden jerk, he drives the pecker against the shuttle, so as to throw it across the warp upon the shuttle-race, into the other trough *I*, leaving the yarn of the weft, which was wound on the bobbin after it, in the space between the divided yarns. With his left-hand he pulls the lay towards him ; and, by means of the reed, the yarn of the weft, which before was lying loose between the warp, is driven up towards

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the cloth-roll: the weaver now presses down his other foot, which reverses the operation, pulling down the heddle which was up before, and raising that which before was depressed. By the other pecker he then throws the shuttle back again, leaving the woof after it between the yarns of the warp; and, by drawing up the batten, beats it close up to the thread before thrown.

In this manner the operation is continued until a few inches are woven; it is then wound upon the cloth-roll, by putting a short lever into a hole made in the roll, and turning it round, a click acting in the teeth of a ferrated wheel, prevents the return of the roll. At each end of the yarn-roll A, (*fig. 1.*) a cord is tied to the frame of the loom; the other ends of the cords have weights hanging to them. The rope causes a friction, which prevents the roll from turning (unless the yarn is drawn by the cloth-beam), and always preserves a proper degree of tension in the yarn.

T T (*fig. 1.*) are two smooth sticks (cotton-weavers have usually three) put between the yarns, to preserve the lease, and keep the threads or yarns from entangling.

In cotton-weaving these sticks or rods are kept at an uniform distance from the heddles, either by tying them together, or by a small cord with a hook at one end, which lays hold of the front rod, and a weight at the other, which hang over the yarn-beam.

The cloth is kept extended during the operation of weaving, by means of two hard pieces of wood, called a templet, with small sharp points in their ends, which lay hold of the edges, or selvages, of the cloth.

These pieces are connected by a cord passing obliquely through holes, or notches, in each piece. By this cord they can be lengthened or shortened, according to the breadth of the web.

They are kept flat after the cloth is stretched by a small bar turning on a centre fixed in one of the pieces of wood. This stretcher is called the templet. Silk-weavers usually stretch their cloth by means of two small sharp-pointed hooks fastened to the ends of two strings, with little weights at the other ends; and the strings are made to pass over little pulleys in each side of the loom, at a suitable distance from the selvages of the cloth.

The perfection of the work depends very much upon the previous operations which the yarn must undergo. It is obvious that the yarns of the warp must be stretched with great parallelism and equality of tension, so that when the cloth is finished, every individual yarn may bear an equal share of any strain which tends to tear the cloth; hence great care must be taken to stretch the yarns of the warp to an equal length, and roll them with great regularity upon the yarn-roll. These operations are called warping and beaming. Previous to warping, the yarn must be prepared by sizing or starching, in order to cement all the loose fibres, and render the yarn smooth.

The spinners of yarn, whether they employ machinery or not, usually reel the yarn into skeins and hanks of a determinate length; and the weight of these hanks, or the number which will weigh one pound, is the denomination for the fineness of the yarn. (See *Manufacture of COTTON.*) In this state the yarn is bought by the weaver. The hanks of yarn are first boiled in water; if it is linen-yarn a little soap and potash are put into the water, and for cotton-yarn a small portion of flour is added, to render the thread firm. When the hanks are perfectly dry they are wound off upon bobbins, each thread having a separate bobbin, and a certain length is wound upon each. This winding is performed by a very simple hand-wheel to turn the bobbin rapidly round, the hanks of yarn being extended upon a reel, or

over two small reels placed at a distance asunder, which are called wisks.

Warping.—The object of this operation is to stretch the whole number of parallel threads which are to form the warp of the cloth to an equal length. For this purpose as many of the above bobbins are taken as will furnish the quantity of threads which is required in the warp of the piece of cloth. The bobbins are usually one-fourth or one-sixth of the number of threads required, and are mounted on spindles in a frame, so that the thread can draw off freely from them. All these threads are drawn off at once, so as to combine them all into one clue, which will be ready for the warp. The ancient method was to draw out the warp at full length, and stretch it in a field; and this is still practised in India and China, but is so very uncertain in our climate that it is seldom used. The present mode of warping is either by the warping-frame or warping-mill.

The warping-frame is a large wooden frame, which is fixed up against a wall in a vertical position. The upright sides of the frame are pierced with holes to receive wooden pins, which project sufficiently to wind the clue of yarns for the warp round them.

The operator having the threads which are to compose the warp wound on the bobbins before-mentioned, places those bobbins in a frame; then tying the ends of all the threads together, and attaching them to one of the pins at one end of the frame, he gathered all the threads in his hand into one clue; and permitting them to slip through his fingers, he walked to the other end, where he passed the yarns over the pin fixed there, and then returned to the former end of the frame and passed the warp over another pin, then went back again, and so on till he formed the required length of the warp. This being done, he secured the end of the warp by crossing it round the pin, and then he worked back and returned over all the same space again, laying the threads over the same pins, so as to double the clue; and he repeated the doubling until the number of threads necessary for the breadth was made up. The number of doublings would be according to the number of bobbins and threads which he took in his hand at once.

This method is used very much in France, particularly at Lyons: it is also used in Devonshire. It is adapted to the weaving carried on in cottages, because the frame is fixed close to the wall, and takes little or no room; but the warping-mill or reel is very superior, and is adopted in all improved manufactures where the warping is a separate business, and is usually done at the mill where the yarn is spun.

The warping-mill is a large reel of a cylindrical form, or rather of a prismatic form, being made with twelve, eighteen, or more sides. The reel is usually about six feet diameter and seven feet high: it is turned round on a vertical axis by a band, passing from a grooved wheel which is turned by a winch, and is placed beneath the seat on which the warper sits. (See a figure of the warping-machine for silk *Plate Silk, fig. 6.*) The bobbins which contain the yarn are placed on a vertical rack suspended from the ceiling, and the threads from them are all collected together and passed between two small upright rollers in a clue, which is wound up by the reel when it is turned round. To guide the clue and distribute it equally on the length of the reel, the above rollers are fixed on a piece of wood, which slides perpendicularly on an upright bar fixed at one side of the reel. The sliding-piece is suspended by a small cord, wrapped round a part of the perpendicular axis that rises above the reel. The cord passes over a pulley at the top of the upright bar, and goes down to the sliding-piece which carries the two rollers. When the reel turns round, the guide-rollers are slowly drawn

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drawn up by the coiling of this cord round the axis; and the yarn is wound in a regular spiral about the reel, until the length which the warp requires is wound upon it. When the full length of the warp is wound on the reel, the clue of thread is crossed over pins projecting from the frame of the reel, and the mill is then turned the reverse way, so that the slider and guide-rollers descend, and the yarn is laid downwards along the same spiral which it before ascended, so as to double the clue of thread; and this doubling is repeated until the required number of threads is collected together in one clue upon the reel.

When the warp is thus completed, it is taken off the reel and wound upon a stick into a ball; the crossings which distinguish the different returns or doublings of the simple clue being first properly secured, as a means of dividing the warp into as many equal portions as is necessary for the convenience of the weaver, in counting the threads in the succeeding operation of beaming.

There is likewise another kind of division of the threads of the warp; this is called the leaf, and serves to separate all the threads which are to go through one of the heddles of the loom, from those which are to go through the other heddle. To effect this separation, the bobbins from which the threads are drawn are arranged in two rows, and a thread is alternately drawn from the upper row and from the lower row. Then at the beginning and end of every doubling of the warp, the threads of one row of bobbins are crossed over the threads of the other row, and two pins are put into the crossings to retain them. These pins are put into holes made in pieces of board fixed to the warping-reel. One of these boards at the top of the reel is fixed fast, but the other is moveable, and can be fixed at any part of the reel, according to the length of the warp.

In the most improved warping-machines, the separation is made by an apparatus called in Scotland the heck. It consists of a row of steel pins with eyes through one end of each for the threads to pass through like large needles. These are stuck into two pieces of wood, by which they are supported in a row near to the warping-reel. Every alternate pin in the row is fastened in one piece of wood, and the intermediate pins are fastened in the other piece, so that by lifting up one piece of wood the pins and threads belonging to it will be raised up, whilst the intermediate pins and threads are held down. This occasions the division of the threads, and a pin is put in to keep them so divided. The other piece of wood is then lifted up, which occasions all the threads to be crossed; that is, every thread forms a cross over that which is adjacent to it. A second pin is then put in, and before the warp is taken off from the reel, this crossing is secured by a string.

Beaming.—When the weaver receives his warp in a large ball or bundle, he proceeds to roll it up regularly upon the yarn-roller of his loom: this is called beaming. For this purpose he employs an instrument called a separator, or ravel, which consists of a number of shreds of cane, fastened together, and fixed to a rail of wood, like the teeth of a long comb; the threads are intended to be put into the spaces between these teeth, so as to stretch the warp to its proper breadth.

Ravels are somewhat like reeds, but much coarser, and are also of different dimensions. One proper for the purpose being found, one of the small divisions of the warp is placed in every interval between two of the teeth. The upper part of the ravel, called the cape, is then put on, to secure the threads from getting out between the teeth, and the operation of winding the warp upon the beam commences. In broad works, two persons are employed to

hold the ravel, which serves to guide the threads of the warp, and to spread them regularly upon the beam; one or two other persons keep the threads at a proper degree of tension, and one more turns the beam upon its centre.

The knottings which secure the crossings or doublings made in warping, are very useful to the weaver in beaming, to ascertain the number of threads, and to distribute them with regularity. He cuts the knotting before he can put the warp in the ravel, but he still keeps them distinct by a small cord.

The French weavers use a small reel, upon which they wind the warp from the ball, and then from this reel they draw off the warp through the ravel, by winding up the beam. The reel is loaded with a weight, to make a regular friction, and draw the warp with a regular tension.

Drawing.—The warp being regularly wound upon the beam, the weaver must pass every yarn through its appropriate eye or loop in the heddles: this operation is called drawing. Two rods are first inserted into the leaf formed by the pins in the warping-mill, and the ends of these rods are tied together; the twine by which the leaf was secured is then cut away, and the warp stretched to its proper breadth. The yarn-beam is suspended by cords behind the heddles, somewhat higher, so that the warp hangs down perpendicularly. The weaver places himself in front of the heddles, and opens the eye of each heddle in succession; and it is the business of another person, placed behind, to select every thread in its order, and deliver it to be drawn through the open eyes of the heddles. The succession in which the threads are to be delivered is easily ascertained by the leaf-rods, as every thread crosses that next to it. The warp, after passing through the heddles, is drawn through the reed by an instrument called a sley, or reed-hook, and two threads are taken through every interval in the reed.

The leaf-rods being passed through the intervals which form the leaf, every thread will be found to pass over the first rod, and under the second; the next thread passes under the first, and over the second, and so on alternately. By this contrivance every thread is kept distinct from that on either side of it, and if broken, its true situation in the warp may be easily and quickly found. This is of such importance, that too much care cannot be taken to preserve the accuracy of the leaf. There is likewise a third rod, which divides the warp into what is usually called *splits*, for two threads alternately pass over and under it; and these two threads also pass through the same interval betwixt the splits of the reed.

These operations being finished, the cords or mounting which move the heddles are applied; the reed is placed in the lay, or batten, and the warp is knotted together into small portions, which are tied to a shaft, and connected by cords to the cloth-beam, and the yarns are stretched ready to begin the weaving.

Manner of Weaving.—The operations of weaving are simple, and soon learned, but require much practice to perform them with dexterity.

In pressing down the treadles of a loom, most beginners are apt to apply the weight or force of the foot much too suddenly. The bad consequences of this are particularly felt in weaving fine or weak cotton-yarn; for the body of the warp must sustain a stress nearly equal to the force with which the weaver's foot is applied to the treadle. The art of spinning has not yet been brought to such perfection as to make every thread capable of bearing its fair proportion of this stress. Besides this, every individual thread is subjected to all the friction occasioned by the heddles and splits of the reed, between which the threads pass, and with which

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which they are generally in contrast when rising and sinking. A sudden pressure of the foot on the treadle must cause a proportional increase of the strokes upon the warp, and also of the friction. As it is impossible to make every thread equally strong and equally tight, those which are the weakest, or the tightest, must bear much more than their equal proportion of the strokes, and are broken very frequently. Even with the greatest attention, more time is lost in tying and replacing them, than would have been sufficient for weaving a very considerable quantity into cloth.

If the weaver, from inattention, continues the operation after one or more warp-threads are broken, the consequence is still worse. The broken thread cannot retain its parallel situation to the rest, but crossing over or between those nearest to it, either breaks them also, or interrupts the passage of the shuttle: it frequently does both.

In every kind of weaving, and especially in thin wiry fabrics, much of the beauty of the cloths depends upon the weft being well stretched. If the motion given to the shuttle be too rapid, it is very apt to recoil, and thus to slacken the thread. It has also a greater tendency, either to break the wool altogether, or to unwind it from the pirn or bobbin of the shuttle in doubles, which, if not picked out, would destroy the regularity of the fabric. The weft of muslins and thin cotton goods is generally woven into the cloth in a wet state.

This tends to lay the ends of the fibres of cotton smooth and parallel, and its effect is similar to that of dressing of the warp.

The person who winds the weft upon the pirn ought to be very careful that it be well formed, so as to unwind freely. The best shape for those used in the fly-shuttle is that of a cone; and the thread ought to traverse freely round the cone, in the form of a spiral, or screw, during the operation of winding.

The same wheel which is used for winding the warp upon the bobbins preparatory to warping, is also fit for winding the weft on the pirn. It only requires a spindle of a different shape, with a screw at one end, upon which the pirn, or bobbin of the shuttle, can be fixed. The wheel is so constructed, that the spindles may be easily shifted, to adapt it for either purpose.

The reeds are formed of a number of short pieces of reed or cane, or of brass wire, fastened parallel to each other between two sticks, and cemented with pitch. This frame is enclosed between two pieces of the frame of the lay, one of which is made wide, to form the shuttle-race; the other piece, which is the lay-cap, extends across the frame, but is fitted so that it can be easily removed to take away the reeds, and substitute a finer or coarser sort, as the nature of the goods to be woven require. The manufacture of reeds, both of cane and of steel, is a separate trade. These are fully described in *Les Arts et Metiers*, vols. 9 and 15.

To render the fabric of the cloth uniform in thickness, the lay or batten must be brought forward with the same force every time.

In weaving some kinds of soft or light goods, the reed is not fixed fast to the lay-cap, but is held in its place by a long thin piece of wood, which is elastic, and yields or springs when the weft is beaten up. In some cases the reed is sustained by a double woollen cord, stretched across the lay, just beneath the lay-cap, and twisted; this bears the reed, and is very elastic, but can be rendered more stiff by twisting the two cords tighter.

In the common operation of weaving, a regular force of the stroke for beating up the weft must be acquired by practice. It is, however, of consequence to the weaver to

mount or prepare his loom in such a manner, that the range or swing of the lay may be in proportion to the thickness of his cloth. As the lay swings backwards and forwards, upon centres placed above, its motion is similar to that of a pendulum. Now the greater the arc, or range through which the lay passes, the greater will be its effect in driving home the weft strongly, and the thicker the fabric of cloth will be, as far as that depends upon the closeness of the weft. For this reason, in weaving coarse and heavy goods, the heddles ought to be hung at a greater distance from the place where the weft is struck up, and consequently where the cloth begins to be formed, than would be proper in light work. The line of the last wrought shot of weft is called by the weavers the fell. The pivots upon which the lay vibrates ought, in general, to be so placed, that the reed will be exactly in the middle, between the fell and the heddles, when the lay hangs perpendicularly. As the fell is constantly varying in its situation during the operation, it will be proper to take its medium; that is, the place where the fell will be when half as much is woven as can be done without taking it up on the cloth-roll, and drawing fresh yarn from the yarn-roll.

The periods for taking up the cloth ought always to be short in weaving light goods; for the less that the extremes of the fell vary from the medium, the more regular will be the arc or swing of the lay. Mr. James Hall had a patent, in 1803, for a method of perpetually winding up the cloth-beam, so as to take away the cloth as fast as it was woven, or shoot by shoot. This was effected in a simple manner by a ratchet-wheel fixed on the end of the cloth-beam, and a proper catch to move it round one tooth at a time: the catch was actuated by the motion of the lay. A similar method is used in ribband-weaving.

The variations in the structure of looms from that which we have described, are not material. The framing is varied in almost every different kind of loom, and ought always to be suitable in strength to the kind of cloth which is to be woven. The loom used for silk is very slight in all its parts; but for carpet and sail-cloth it must be very strong.

In looms for heavy goods, the cloth-beam is not placed at the breast of the weaver, as it is so large that it would impede his working; the cloth is therefore passed over a fixed bar in the place of the cloth-beam represented, and the beam is placed lower down, and near the weaver's feet, out of the way of his knees. The heddles are connected by levers, in some looms, instead of pulleys; but the effect is always the same; *viz.* to make one heddle ascend when the other descends. For weaving fine goods, the heddles would be inconveniently close together, if all the yarns went through two heddles; hence they use four heddles instead of two; but their action is just the same, because they are connected together in pairs, and when one pair rises the other pair sinks. Many looms are still made without the fly-shuttle; and in that case the shuttle is merely thrown from one hand to the other, and then thrown back again: this obliges the weaver to change his hands continually, and the operation is more complicated. For wide cloths, which are more than a man can reach across, two persons were always employed before the fly-shuttle was introduced, which is only within a few years; but by its assistance one person can weave the greatest breadths. The fly-shuttle is the best for all kinds of work, and its construction is so simple that no other ought to be used.

Treatment of different Kinds of Yarns.—The manner of weaving all kinds of plain cloth is much the same, whether it is wool, silk, flax, or cotton; except that the two latter

require what is called *dressing*. Silk and woollen warps require little preparation after being put into the loom, except to clear the yarn occasionally with a comb, to remove knots or lumps which might catch in passing through the reed; the comb detects such lumps, and they are removed with the assistance of a pair of scissors. Flax and cotton, but particularly the latter, require the warp to be dressed with some glutinous matter, to cement the fibres, and lay them close. This is applied in a fluid state, and as the weaving does not proceed well after it is suffered to dry, the warp is dressed with a brush when in the loom, a small quantity at a time, immediately before it is woven.

Dressing.—The use of dressing is to give to yarn sufficient strength or tenacity, to enable it to bear the operation of weaving into cloth. By laying smooth all the ends of the fibres of the raw materials, from which the yarn is spun, it tends both to diminish the friction during the process, and to render the cloth smooth and glossy when finished. The dressing in common use is simply a mucilage of vegetable matter boiled to a consistency in water. Wheat-flour, boiled to a paste like that used by book-binders, or sometimes potatoes, are commonly employed. These answer sufficiently well in giving to the yarn both the smoothness and tenacity required; but the great objection to them is, that they are too easily affected by the action of the atmosphere. When dressed yarn is allowed to stand exposed to the air for any considerable time, before being woven into cloth, it becomes hard, brittle, and comparatively inflexible. It is then tedious and troublesome to weave, and the cloth is rough, wiry, and uneven. This is chiefly remarked in dry weather, when the weavers of fine cloth find it necessary to work up their yarn as speedily as possible, after it is dressed. To counteract this inconveniency, herring or beef brine, and other saline substances which attract moisture, are sometimes mixed in small quantities with the dressing: but this has not been completely and generally successful; probably, because the proportions have not been sufficiently attended to; for a superabundance of moisture is equally prejudicial with a deficiency. The variations of the moisture of the air are so great and frequent, that it is impossible to fix any universal rule for the quantity of salt to be mixed. Some weavers put butter-milk in the paste.

To apply the dressing, the weaver must suspend the operation of weaving, whenever he has worked up that quantity of warp which he has dressed, or within two or three inches; he then quits his seat, and applies the comb to clear away knots and burs; next pushes back the lease-rods towards the yarn-roll, one at a time, and if they slide freely between the yarns, it shews they are clear from knots; he then brushes the yarn with the paste by two brushes, holding one in each hand. The superfluous humidity is afterwards dried by fanning the yarns with a large fan, and then a small quantity of grease is brushed over the yarn; the lease-rods are returned to their proper position, and the weaving is resumed.

Dressing is of the first importance in weaving warps spun from flax or cotton; for it is impossible to produce work of a good quality, unless care be used in dressing the warp.

The same practice, when used upon silk, has a very destructive tendency: it injures the colours of the silk when used, as it is sometimes very improperly, by the weavers of white satin. The injury done to the work is irreparable. In cotton, the operation of dressing is indispensable; but in silk, this is by no means the case.

The preparation of paste or size for warp, has been the subject of several patents. Mr. Foden, in 1799, recom-

mends a quantity of calcined gypsum, or plaster of Paris, to be reduced to a very fine powder, and then mixed with alum, fugar, and the farina or starch of potatoes, or any other vegetable farina. This powder, when mixed well with cold water, forms a soft paste, to which boiling water is to be added, and the mixture thoroughly stirred till it becomes sufficiently gelatinous for use.

Another size, for which Mr. Wilks had a patent in 1801, is prepared as follows:—The starch or flour is to be extracted from any kind of potatoes which are mealy when boiled, by grating them while raw (but washed clean) into a tub of water. The water, thus impregnated with the grated potatoes, is run through a sieve or strainer, which will retain the coarser and fibrous parts of the potatoes, but admit the finer particles, constituting the starch or flour, to pass with the water into a vessel beneath the sieve or strainer. This water must remain in the vessel several hours undisturbed, to permit the starch to subside to the bottom; then the water is poured off, and the starch so obtained is put into fresh water, and passed through a finer sieve into another tub, where the starch is left to subside to the bottom as before, and the water is again poured off.

About two-thirds the quantity of potatoes, which furnished the starch, are also to be boiled without peeling, so as to make them mealy when boiled; they are then mashed, and diluted with water, so that they will pass through a sieve into a boiler. In this the mashed potatoes are heated till they almost boil; and the starch from the grated potatoes is then to be added, and the whole boiled and stirred for 20 minutes, when it will become paste proper for use. It should be spread in a flat open vessel to cool.

Improved System of Weaving by Machinery.—In our article COTTON we mentioned that weaving-looms, worked by mechanical power, were then coming into use: since the time that article was printed these have made great advances; but to use them with advantage, the preparatory processes of warping and dressing must be conducted in a particular manner. Many attempts have been made to diminish the number of operations through which the yarn must pass by combining several together. Mr. Stuart had a patent in 1800 for sizing or starching cotton-yarn whilst in the cop, so that it would be ready to warp at once. Mr. Marland had a patent in 1805 for the same object: his plan was to expose the cops of cotton to the action of the hot starch in an exhausted receiver; the pressure of the atmosphere being thus removed, the size penetrated readily to the centre. It was found difficult to dry the cop perfectly, and the threads were sometimes so glued together as to render the winding off difficult.

Another plan has therefore been introduced both for flax and cotton: this is to wind off the yarn from the cop or bobbin in which it is spun, and gather it upon the bobbins ready for the warping; by this manner the reeling is saved. A small quantity of starch is applied to the yarn during the operation, by causing it to pass over a horizontal wooden cylinder, which revolves on its axis in a trough filled with fluid starch. The threads, in passing from the cop to the bobbin, are drawn over the upper surface of the cylinder, and receive the starch with which it is covered. The winding machine for this actuated a great number of bobbins at once; the warping is then conducted, as we have before described, and the dressing is performed in the loom whilst weaving, that is, if woven by hand; but for the power-loom it is dressed previously to placing it in the loom.

Dressing Machines.—Mr. Johnson, of Stockport, had a patent, in 1804, for a method of dressing whole webs of warp at once,

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once, by a machine. The yarns were wound off from the bobbins or cops of the spinning machines upon beams or rollers. Several of these rollers were placed parallel to each other, in an horizontal direction, at the opposite ends of the machine, from three to six at each end; and the yarns from them were all combined together in one web, which was received and rolled up on the yarn-beam of the loom placed in the middle of the machine, and raised up considerably above the other rollers, so that the yarns proceeded from both ends of the machine towards the middle. In their passage they passed through several reeds to keep them separate, and were supplied with the paste by passing over two cylinders revolving in a trough of fluid paste. This paste was dressed or worked into the yarn by means of two brushes, of a length equal to the breadth of the web; one of the brushes acted upon the upper side of the yarns, and the other on the lower side. A similar pair of brushes were applied at both ends; each brush had a motion given to it by means of cranks, exactly similar to the movement with which the weaver brushes the yarn in the loom. Near the yarn-roller a fan was placed, like that used in a winnowing machine, which blew a current of air through the yarns of the warp to dry them before they were rolled up by the beam. To preserve the lease, the yarns were conducted through a pair of heddles, similar to those of the loom, but they remained slack to avoid friction. The machine was moved by the mill with a constant and regular movement.

When a warp is thus warped, beamed, and dressed, the yarn-beam is carried to a loom, on which the yarn is just exhausted, and is made to replace the empty yarn-roll. The ends of the yarn are joined to the old yarns by twisting, and are thus drawn through the heddles and reed, so that the weaving can be resumed with very little loss of time, and the weaver can proceed with his work without any interruption for dressing. The principal objection to the above machine is the friction which the yarns must undergo in crushing, and in passing through so many reeds: it was, however, practised in a large work at Stockport; but the weaving was performed by hand.

Another dressing machine was invented by Mr. M'Adam, and he obtained a patent in 1806: it is practised by Mr. Monteith, at Pollockshaws near Glasgow. This machine is very much like the former in its manner of action. Instead of using three, four, or six beams at each end of the machine, there are only two beams, each containing one half the number of yarns for the intended warp. The starch is supplied in the same manner as the former, or sometimes by making the two yarn-beams themselves turn in a trough of starch without employing a separate cylinder. The brushing is performed in a more simple and effectual manner by using cylindrical brushes, which revolve with a regular motion, two of them are applied on the upper side of the warp, and two on the lower side; also four fanners are applied to dry the warp instead of one. The yarns were conducted between reeds and through heddles, like the first machine; and hence the same objection of friction applies to both.

Mr. Duncan, in his *Essays on Weaving*, describes another method of dressing warps, which is practised by Mr. Dunlop at Barrowfield. In this the yarn is warped and beamed in the usual manner, upon a yarn-roll: from this the yarn is unwound, and taken up upon another beam; and in its passage from one to the other it is extended, so that the picking and clearing can be performed in the usual way by hand with a comb and scissors, and the dressing is applied with brushes in the usual way: beneath the warp a fan is placed, to blow a current of air up through the yarns and dry them. In this machine all the operations, except the fanning, are

performed by hand; the advantage, therefore, consists only in the division of labour, by making the dressing and weaving distinct operations.

Power-Looms.—In the article *COTTON* we have mentioned Mr. Dolignon's claim to the invention of weaving by mechanical power.

The original project, we believe, was by M. De Gennes, and is published in the *Philosophical Transactions* for 1768, N^o 140. See also Lowthorp's *Abridgment*, vol. i. p. 499. This is a very ingenious invention. The fly-shuttle was not then invented, and he supplied the want of it by a contrivance which held the shuttle as it were in a hand by fingers; this carried it half way through the cloth, and then it was transferred to another similar hand, which drew it through the remainder. By this means there was a greater certainty than in throwing the shuttle from one side to the other, because the shuttle always continued engaged with the mechanism: the whole machine is ingenious and worthy of notice.

M. Vaucanson, the celebrated French mechanist, made a machine for weaving ten ribbands at a time, which was worked by a circular motion given by the workman; and it might, therefore, have been worked by mechanical power. This is described in the *Encyclopede Methodique* in great detail, with ten folding plates, and is an ingenious machine.

We believe both these inventions were prior to that of Mr. Dolignon; and also that the merit of inventing the machine, and first reducing it to practice, is due to Mr. Austin, of Glasgow. In this gentleman's memoir to the Society of Arts, he states, that his first attempt was made in the year 1789, when he entered a caveat for a patent, but did not apply for it further; since that time he made many improvements upon the original plan. In 1796 a report in its favour was made by the Chamber of Commerce and Manufactures at Glasgow; and in 1798, a loom was set at work at Mr. J. Monteith's spinning works, at Pollockshaws near Glasgow, which answered the purpose so well, that a building was erected by Mr. Monteith for containing thirty looms, and afterwards another to hold about two hundred.

Mr. Austin's Power-Loom.—The model from which our drawing (*Plate I. Weaving*) was made, is deposited in the Society of Arts: it is an improvement upon the looms constructed for Mr. Monteith.

The drawing *Plate I.* is a perspective view, exhibiting the whole loom at one glance: it is viewed from the back rather than from the front.

A is a square iron axis extending through the whole length of the machine; to this the power of the first mover is applied by a cog-wheel B, of thirty-six teeth, turned by a pinion of twelve leaves fixed to the axis of the fly-wheel D. A handle is fixed to one of the arms of the wheel to give motion to the model; but in the large machine a live and dead pulley are adapted to the axis of the fly-wheel; and by means of an endless strap, the power is communicated from any convenient part of the mill in which a great number of looms are placed together.

The axis A has several eccentric wheels or camms fixed upon it; as these revolve they give motion to a number of levers or treadles, by which all the usual operations of the loom are performed at the proper intervals: these are,

First, To separate the two parts of the yarns of the warp, as shewn at G, and admit the passage of the shuttle.

Secondly, To throw the shuttle, in order to lay the weft or cross-threads of the cloth.

Thirdly, To move the lay 7, 8, and return it; so that the reed g will beat up the weft close to the fell, or preceding

ceding shoot of the weft: this renders the cloth of uniform texture.

Fourthly, To wind up the cloth upon the cloth-roll, as fast as it is formed by the preceding operations.

The yarns, which are to form the warp of the cloth, are warped in the manner before described upon the yarn-roll *F*; and from thence they are extended horizontally to the cloth-roll *E*, of which only a small part can be seen at the opposite side of the loom: in their way the yarns pass through the eyes of the heddles *G H*, which effect the first operation above-mentioned. Each heddle is composed of a number of perpendicular threads equal to half the number of yarns in the warp; these are stretched between two small rods *aa* and *bb*, and in the middle of each thread is a small eye, through which a yarn of the warp is passed; thus, the first yarn of the warp is passed through the eye of the heddle *G*, but has no connection with the heddle *H*, because it passes between its threads. The second yarn is put through the eye of the heddle *H*, but has no connection with *G*; the third yarn is attached to *H*; the fourth to *G*, and so on alternately throughout the whole number. By this means if one heddle is raised up, and the other at the same time depressed, a separation of the yarns will take place as shewn at *G*, every other yarn being raised up, whilst the intermediate ones are drawn down, so as to admit the passage of the shuttle and weft between them.

The two heddles are moved by camms upon the main axis *A*; and they are so connected by short levers *I I*, which are suspended from the upper part of the loom, that when one heddle is pulled down, the other will be drawn up at the same time, because they are suspended from the opposite ends of the levers *I*.

The camms on the main axis for the heddles are marked *L*; the two are exactly similar, but are reversed upon the axis; that is, the shortest radius of one is placed on the same side with the longest of the other. They act upon two levers, which are the same as the treadles in a common loom; only one of these treadles or levers (*viz.* that which belongs to the camm *L*) can be seen at *M*, the other lever being concealed from the view; both levers move on centres at *n* between the small uprights *dd*; the other ends slide freely up and down between similar uprights at the opposite side of the frame, which cannot be seen in the figure; the levers are connected with the heddles, which being suspended from the levers *I* as before mentioned, the levers will therefore move in contrary directions, the one rising when the other is pressed down by the action of the camm on the axis *A*.

The connection between the levers or treadles *M* and the heddles *G H*, is made by cords communicating with two counter-levers *O P*, which are centered in uprights supported by the frame at the ends of the machine. The counter-levers *O P* are connected with rods *b* and *k*, and these by a double cord are attached to the heddle-rods *aa* and *bb*.

This machinery which we have now described effects the separation of the warp thus: when the axis *A* turns round, every revolution of its camms *L* will cause two separations of the warp, and each one in a different manner, for those yarns which are raised up at one time are drawn down the next.

The second operation, *viz.* throwing the shuttle, is performed by two camms *R S*, which are reversed to each other upon the axis *A*. They act upon two levers, only one of which can be seen at *T*; they are placed beneath the camms. The shuttle requires to be projected with a sudden jerk; these levers are therefore centered at *d* on the

same pin as the levers *M* and *N*, but the other ends press down smaller levers *W*, which are centered at the opposite end of the frame, and lie beneath the long levers. The extreme ends of these smaller levers are connected by a strap *f* with a segment of a wheel, which has a long stem of whalebone *Y* fastened to it; and by means of two strings, one of which is shewn at *g 4*, it moves the peckers or drivers *z* upon the wires *3, 3*, and throws the shuttle. The shuttle, which is shewn in a separate figure, is pointed at each end, and shod with iron: it contains two small rollers *31* upon which it runs; and as they project through both surfaces, it will run either way upwards, or either end first. In the centre of the shuttle is an oblong mortise, containing the pirn or bobbin *33*, on which the thread for the weft of the cloth is wound; and the end of the weft marked *34*, is brought through a small glass tube, called the eye of the shuttle.

The action of the mechanism for throwing the shuttle is as follows:—By the revolution of the camm *R*, the long lever beneath it is depressed, and at the same time the extremity of the shorter lever *W* descends, but with an increased velocity; this by means of the strap *f* turns the segment of a wheel on its centre, and its tail *Y* snatches the string *g 4* of the pecker *z*, and makes it strike against the shuttle with such a velocity, as to drive the shuttle out of the trough *Q*, across the shuttle-race, into the opposite trough, where it will push back the pecker, and remain at rest in the trough ready for the next stroke: by this stroke it will be returned back again with an action similar to the last, but occasioned by the other camm *S*, and its corresponding levers.

The threads of the warp, which are lowest when the separation takes place, are drawn down by their heddle *G* or *H*, so as to lie close upon the shuttle-race, and cause no obstruction to the passage of the shuttle. To facilitate this, the shuttle must be very smooth on the surface, that it may not catch the threads and be stopped. The shuttle-race is inclined towards the reed, both that the yarn may lie flat upon it, and that the shuttle may not be liable to run off its race; for as it leaves the weft, which is drawn off from its bobbin, in the space between the divided yarns of the warp, it might be drawn off its race sideways, without this precaution. In this manner the second operation is performed.

The third motion is that of the reed *g*: this is fixed close behind the shuttle-race, and is a frame containing a great number of parallel slips of reed or cane; between these the yarns of the warp pass, and when the whole frame of reeds is moved towards the cloth-roll *E*, they will act in the manner of a comb, to beat up the thread of the weft, which is left by the shuttle lying loosely between the yarns of the warp.

For this purpose, the shuttle-race, reeds, peckers, &c. and their stem *Y*, with its segment of a wheel, are all placed on a framer which moves on hinges at the lower ends, *8*, of the two upright slides *7 8*. This frame, which is termed the lay, is drawn backwards by means of straps *10, 10*, rolled upon pulleys *11*, fastened upon the axis *12*; upon this same axis are two other smaller pulleys, upon which two straps, *13*, are rolled, to connect with the long levers *14*, which are moved by the camms *15*, upon the axis *A*.

The long levers, *14*, are centered at one end of the frame, and the pulleys on the axis, *12*, being of different diameters, the motion of the reeds will be performed very quickly. To move the lay in a contrary direction, and give the stroke to beat up the weft, two large weights, like *m*, are suspended by straps from pulleys on an horizontal axis, which carries two larger wheels *x*; on these, straps are wound, to communicate

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nicate with the upright sides, 7 8, of the lay, and draw it forwards.

When the loom is acting very quickly, these weights would not act with sufficient sharpness to throw the reeds against the threads of the weft with the proper force.

The weights are therefore connected by spiral wire-springs, with long levers 16, which are pressed down by a camm or rather tappet 17, fixed on the main axis. These levers act before the lay is at liberty to move, and by pressing down the levers extend the springs; consequently, as soon as the camm 15 suffers the lever 14 to rise, the springs act instantaneously, to throw the lay and the reeds forwards to beat up the weft.

The instant after the blow has been given, the lay is drawn back again by the camm 15, and returned into the vertical position, in which situation the lay must continue whilst the shuttle is thrown; for this purpose, the out-sides of the camms 15 are portions of circles. This completes the third motion.

As fast as the cloth is fabricated by the foregoing movements, it is gathered upon the cloth-roll E. This is turned slowly round by a small crank 19, on the extreme end of the main axis A; the crank moves a small rod 20 up and down, in order to turn a small ratchet-wheel round one tooth each revolution of the main axis; the return of the ratchet is prevented by a click. On the axis 21 of the ratchet-wheel is an endless screw, to engage the teeth of a cog-wheel upon the end of the cloth-roll, and give it a slow motion.

The yarn is kept to a proper degree of tension by the friction occasioned by a line 28 passed twice round the yarn-roll, one end being fastened to the frame, and the other to a lever 30, loaded with a weight.

The framing of the loom is too evident to need description. In the construction of the machine, the principal circumstance to be attended to, is the figure of the different camms; also that they are placed upon the axis A in the proper positions relative to each other. These cautions will ensure the accurate performance of the machine.

The camm R or S, for throwing the shuttle, is formed with a sudden beak or projection, that it may strike the levers T down instantaneously, and throw the shuttle; from this beak the curve continues circular for some distance, that the lever may be held stationary; the remainder of the camm gradually diminishes its radius like a spiral, and quits the lever, in order to leave it at liberty to rise up when its corresponding lever is forced down by the beak of the other similar camm S.

The camm L for the heddles is made circular where it is to come in contact with the lever, and which is all the time it is in action. This occasions the levers and heddles to be stationary whilst the shuttle is thrown.

The inventor states that, by the addition of some simple improvements, his looms have the following advantages; *viz.* 300 or 400 of them may be worked by one water-wheel, or steam-engine, all of which will weave cloth in a superior manner to what can be done in the common way. They will go at the rate of 60 shoots in a minute, making two yards height of what is called a nine hundred web in an hour. They will keep regular time in working, stop and begin again, as quick as a stop-watch. They will keep constantly going, except at the time of shifting two shuttles, when the weft on the pirns is exhausted. In general, no knots need be tied, and never more than one in place of two, which are requisite in the common way when a thread breaks. In case the shuttle stops in the shed, the lay will not come forwards, and the loom will instantly stop work-

ing. They will weave proportionally slower or quicker, according to the breadth and quality of the web, which may be the broadest now made. They may be mounted with a harness or spot-heddles, to weave any pattern, twilled, striped, &c.

There is but one clove shed, the same in both breadths, and the strain of the working has no effect on the yarn behind the rods.

The fell and temples always keep the same proper distance. There is no time lost in looming, or cutting out the cloth; but it is done while the loom is working, after the first time.

The weft is well stretched, and exactly even to the fabric required.

Every piece of cloth is measured to a straw's breadth, and marked where to be cut at any given length.

The loom will work backwards in case of any accident, or of one or more shoots missing. Every thread is as regular on the yarn-beam as in the cloth, having no more than two threads in the runner. If a thread should appear too coarse or fine in the web, it can be changed, or any stripe altered at pleasure. They will weave the finest yarn more tenderly and regularly than any weaver can do with his hands and feet.

When a thread, either of warp or weft, breaks in it, the loom will instantly stop, without stopping any other loom, and will give warning by the ringing of a bell. A loom of this kind occupies only the same space as a common loom; the expence of it will be about half more; but this additional expence is more than compensated by the various additional machinery employed for preparing the yarn for the common loom, and which this loom renders entirely unnecessary.

The preparatory processes of reeling, winding, warping, beaming, and looming, and the interruptions occasioned by combing, dressing, fanning, greasing, drawing bores, shifting heddles, rods, and temples, which is nearly one-half of the weaver's work, do not happen in these looms. The general waste accompanying the above operations is stated at about six *per cent.* of the value of the yarn, all which occur in the operations of the common loom. The power-loom, without further trouble, performs every operation after the spinning, till the making of the cloth is accomplished, by which a saving is effected of about 20 *per cent.* of the yarn.

The heddles, reed, and brushes, will wear longer than usual, from the regularity of their motion. More than one-half of workmanship will be saved; one weaver and a boy being quite sufficient to manage five looms of coarse work, and three or four in fine work.

Mr. Miller's Power-Loom.—A patent was taken out for this in 1796. It is so much like Mr. Audin's in its general principle, that it is unnecessary to enter into the description. The motions are all produced by camms fixed on a horizontal axis, and operate upon a number of horizontal levers, disposed beneath the loom, in the situation of treadles: in other respects the arrangement of the parts is very different. This is sometimes called the wiper-loom, wiper being a different name for a camm.

Crank Loom by Power.—In this the treadles are actuated by cranks, instead of camms or wipers. The reciprocating motion produced by a crank is not uniform, but accelerated at one time, and retarded at another. This is an advantage in some of the operations of a loom. It is true, that, by means of wipers, any required law of acceleration may be produced; but in a crank, the acceleration must proceed according to one law. The superiority of cranks arises from

from the circumstance, that they will communicate motion in both directions; whereas a cam will only push a lever in one direction, and the return of the motion must be made by a spring or counterweight. Now, if this counterweight is too large, it makes unnecessary loss of power and friction; and if it is too small, there is some uncertainty in the return of the lever.

Mr. Todd of Boulton had a patent, in 1803, for improvements in power-looms.

Mr. Horrocks of Stockport had three successive patents for this kind of machinery, in 1803, 1805, and 1813. The machine described in the latter is a crank-loom; that is, the lay is actuated by a crank to beat up the weft. The principal improvement consists in a system of levers, which transmit the action of this crank to the lay, and so modify it, that the lay will advance quickly, and give an effective stroke to the weft, and then withdraw quickly to a stationary position, in which it will remain whilst the shuttle is thrown. The advantages which are stated are, that a large shuttle may be used, sufficient to hold a full-sized cop of weft: the waste and loss of time by renewing the cop will, therefore, be less. From the smartness of the stroke, less weight will be required on the yarn-beam, and this will occasion the heddles to work more lightly, so as to break fewer threads. From the same cause, more threads of the weft may be laid in an inch, and make closer work.

Mr. Johnson of Preston had a patent in 1805, and another in 1807, for a power-loom, in which the warp is stretched on a vertical plane, instead of horizontal, as in former machines. The advantages of this are stated to be, 1st, that it takes less space; 2d, the reed serves for the shuttle-race, because the shuttle runs upon the reed itself, and, therefore, makes no friction upon the yarns; 3d, also in dressing, picking, and clearing the warp, the attendant always remains in front of the machine, and can continue to watch the machine; whereas, in the other looms, he must quit his post in front, and go round behind the looms for these operations. When the dressing is to be applied to the warp, whilst it is in the loom, that part of the warp is conducted horizontally for that purpose, and a fan is applied to dry the warp.

The latest inventions of power-looms are Mr. Peter Ewart's patent, 1813; and Mr. Duncan's loom, which he calls a vibrating loom.

The Indian Loom.—This is a striking contrast to our power-looms; it consists merely of two bamboo rollers, one for the warp, and the other for the finished cloth; and a pair of heddles. The shuttle performs the double office of shuttle and reed: for this purpose, it is made like a large netting-needle, and of a length somewhat exceeding the breadth of the piece of cloth which is to be woven.

This apparatus the weaver carries to any tree which affords a shade most grateful to him: under this he digs a hole large enough to contain his legs, and the lower part of the gear or heddles; he then stretches his warp, by fastening his bamboo rollers at a due distance from each other on the turf, by wooden pins; the balances of the gear or heddles he fastens to some convenient branch of the tree over his head; and two loops underneath the gear, in which he inserts his great toes, serve instead of treadles; his long shuttle, which performs also the office of a batten, draws the weft, throws the warp, and afterwards strikes it up close to the web. In such looms as this are made those admirable muslins, whose delicate texture the Europeans can never equal, with all their complicated machinery.

The weaving, even of their finest muslins, is thus conducted in the open air, exposed to all the intense heat of

their climate. We know well that this would be impracticable with fine work in this country, even in an ordinary summer day, on account of the sudden drying of the dressing. It is not known what is the substance which the Indian weavers employ for dressing their warps. It might be of use to our manufacturers, were this investigated in a satisfactory manner. It is said to be a decoction of rice, formed by boiling the rice in a small quantity of water, and expressing the juice: when this is cool, it forms a thick glutinous substance, which undergoes some kind of fermentation before it is used.

Figure-weaving.—Having given an account of the nature and process of plain weaving, we must notice the fanciful and ornamental parts of the business. The extent to which this species of manufacture is carried renders it an object of very great national importance, and deserving a more minute description than our limits will admit.

Figures or patterns are produced in cloth, by employing threads of different colours, or of different appearance, in the warp, or in the weft. By the weaving, the threads must be so disposed, that some colours will be concealed and kept at the back, whilst others are kept in the front; and they must occasionally change places, so as to shew as much of each colour, and as often as it is necessary, to make out the figure or pattern.

The weaver has three means of effecting such changes of colour: First, by using different coloured threads in the warp, or threads of different sizes and substances; these are arranged in the warping, and require no change in the manner of weaving. This is confined to striped patterns, the stripes being in the direction of the length of the piece.

Secondly, by employing several shuttles charged with threads of different colours or substances, and changing one for another every time a change of colour is required. This makes stripes across the breadth of the piece; or, when it is combined with a coloured warp, it makes chequered and spotted patterns of great variety.

Thirdly, by employing a variety of heddles, instead of two, as we have hitherto described; each heddle having a certain portion of the warp allotted to it, and provided with a treadle. When this treadle is depressed, only a certain portion of yarns which belong to that heddle will be drawn up, and the rest will be depressed; consequently, when the weft is thrown, all those yarns which are drawn up will appear on the front or top of the cloth; but in the intervals between them, the weft must appear over those threads which are depressed. The number of threads which are thus brought up may be varied as often as the weaver chooses to press his foot upon a different treadle, and by this he produces his pattern.

All these means may be combined together, and give the weaver the means of representing the most complicated patterns.

The principal varieties of woven cloth, including only those which require a different process for their fabrication, are the following:

Stripes are formed upon the cloth either by the warp or by the woof. When the former of these ways is practised, the variation of the process is chiefly the business of the warper; but in the latter case, it is that of the weaver, as he must continually change his shuttle.

By unravelling any shred of striped cloth, it may easily be discovered whether the stripes have been produced by the operation of the warper or those of the weaver.

When the fly-shuttle is used, the changing of the shuttle is very readily effected by a simple contrivance. One of the shuttle-boxes or troughs, as we have before called them,

(*Plate II. Weaving, fig. 2.*) is made in two parts, so that a part of the trough I near the pecker, where the shuttle lies during the time it is at rest, can be removed, and another trough substituted, which contains a different shuttle. For the purpose of making the change with facility, a moveable shuttle-box *n* is suspended by two perpendicular stems *o* from a wire or centre of motion *m* attached to the lay, as is shewn by the dotted lines. The moveable box is just on the same level with the shuttle-trough I, and is divided by partitions into two or three separate troughs, each exactly the width of the regular trough, and as long as is necessary to contain a shuttle. The pecker *k*, and the wire upon which it slides, remain exactly as before described; but by swinging the moveable box *n* on its centre any one of its compartments may be brought to line with the real place for the shuttle-trough in which the pecker runs. The moveable box must have proper catches to hold it exactly in its true positions.

In working with this contrivance a shuttle of a different colour must be placed in each cell or division of the moveable box *n*; and when the weaver desires to change the shuttle he pulls the connecting string. This moves the shuttle-troughs either backwards or forwards, so as to carry away that shuttle which had been just before in use, and place another before the pecker. Then if he pulls the pecker-handle *y* the new shuttle will be thrown across the shuttle-race, just as the old one was in the former instance. If only one moveable shuttle-box is used there will be some limitation in the pattern, because the stripes of different colour must always consist of an even number of the same coloured thread, as two, four, six, &c. This may be obviated, and a greater change of shuttles may be introduced, by using two moveable shuttle-boxes, one at each end of the shuttle-race: in that case the two moveable boxes are provided with cranks and strings, so that the weaver can reach either of them with ease.

Checks are produced by the combined operations of the warper and the weaver.

Tweeled cloths are so various in their textures, and so complicated in their formation, that it is difficult to convey an adequate idea of the mode of constructing them without the aid of several drawings.

In examining any piece of plain cloth, it will be observed that every thread of the weft crosses alternately over and then under every thread of the warp which it comes to; and the same may be said of the warp: in short, the threads of the warp and weft are thus interwoven at every point where they cross each other, and are therefore tacked alternately.

Tweeled cloth is rather different, for only the third, fourth, fifth, sixth, &c. threads cross each other, to form the texture.

Hence two, three, four, or more, of the successive threads or shoots of the weft will be found to pass under or over the same thread of the warp; or, in other words, by tracing any thread of the warp it will be found to pass over two, three, four, or more threads of the woof at once, without any interweaving the warp. Then it crosses and passes between the threads of the weft, and proceeds beneath two, three, four, or more threads, before it makes another passage between the threads of the weft.

Tweeled cloths are of various descriptions, and produce different kinds of patterns; because at all the intersecting points where the threads actually cross or interweave both threads of warp and weft are seen together, and these points are therefore more marked to the eye, even if the warp and weft are of the same colour. These points in plain tweels form parallel lines extending diagonally across the breadth of the cloth, with a different degree of obliquity, according to the

number of weft-threads over or under which the warp-threads pass before an intersection takes place. In the coarsest kinds every third thread is crossed: in finer fabrics they cross each other at intervals of four, five, six, seven, or eight threads; and in some very fine tweeled silks the crossing does not take place until the sixteenth interval.

Tweeling is produced by multiplying and varying the number of heddles, or, as the weavers express it, the number of leaves in the harness, which is the name given to the whole number of heddles employed in a loom; by the use of a back-harness or double-harness, by increasing the number of threads which pass through each split of the reed, and by an endless variety of modes in drawing the yarns through the heddles; also by increasing the number of treadles, and changing the manner of treading them.

The number of treadles requisite to raise all the heddles which must be used to produce very extensive patterns, would be more than one man could manage; for if he placed his foot by mistake on a wrong treadle he would disfigure his pattern. In these cases, recourse is had to a mode of mounting or preparing the loom, by the application of cords to the different heddles of the harness; and a second person is employed to raise the heddles in the order required, by pulling the strings attached to the respective heddles of the back-harness, and each heddle is returned to its first position by means of a leaden weight underneath. This is the most comprehensive apparatus used by weavers, for all fanciful patterns of great extent, and it is called the *DRAW-LOOM*. See that article.

The manner of mounting the harness of looms, to produce all the principal varieties of fabrics, is detailed in our articles *DESIGN, DRAUGHT, and CORDING of Looms*; also *DAMASK, DIAPER, DIMITY, DORNOCK, FUSTIAN, and TAPESTRY*. A perusal of those articles will render it unnecessary for us to proceed farther on that subject in the present article. We shall however describe a most valuable invention, which has of late years come into use, as a substitute for the second person or draw-boy, who must be employed in the draw-loom, by which loom alone all the complicated patterns can be woven.

Machine called the Draw-Boy, because it performs the Office of a Draw-Boy in Weaving.—The saving of labour is not the only advantage of this machine; the certainty of its operation and security from mistake are obvious. The weaver produces the required action upon the most complicated harness by two treadles only, which he works alternately, just with the same motion as in plain cloth-weaving. The machine, when once set up, performs every thing else.

Like most other inventions, this was at first imperfect, but has been gradually improved. We do not know its history, but we have seen great numbers of machines, for carpet-weaving and coarse goods, which have been some years in use. The machine is situated in a small square frame, not larger than a chair, which stands at the side of the loom, and cords from all the different heddles are conducted from the draw-loom down to this frame, where they are arranged in order. Each cord has a knot answering to the handle, which the boy must pull in the common draw-loom; and there is a piece of mechanism actuated by the treadles which at every stroke selects the proper cord, and draws it down so as to raise the heddles belonging to it. The next time it changes its position and takes another cord, and so on until the whole number of cords has been drawn and the pattern completed.

These original machines have a great defect, *viz.* that they only proceed with regularity to raise up all the heddles, until all the cords have been drawn, and one series of changes

has been gone through; but when this is completed, and a repetition of the pattern is wanted, the weaver must stop and restore the machine to its original position by pulling a string. This appears very easy, but it diverts his attention; and if he does not do it at the exact moment his pattern may be spoiled. This defect was remedied by Mr. Alexander Duff, who received a small and inadequate premium from the Society of Arts in 1807, probably because they were not aware of its value and importance; but in 1810 we find them with a liberality truly discouraging to real merit, giving an equal reward to another person, for the most trivial alteration of Duff's machine. The latter machine is alone described in their Transactions; see vol. xxviii.

Mr. Duff's Draw-Boy.—*Fig. 4. Plate II. Weaving,* is a plan of this machine, and *fig. 2.* a perspective view. It is fixed at the side of a draw-loom, in the same place as a draw-boy would stand, and H shew the cords which are to draw the harness. The same letters are used in both figures. A A is a square wooden axis, mounted so as to turn backwards and forwards in the frame B B, on points or centres of motion. At one end of it a pulley D is fixed, to receive a line *aa* fastened to it at the highest point, by means of which the axis receives motion from the two treadles of the loom, one of the treadles being attached to one end of the line, and the other to the opposite end of it. E E are two rails of wood, fixed across the frame parallel to the axis; and *ee* are two brass plates screwed to the rails, and pierced with a great number of holes to receive as many cords. Each cord is tied by one end to a central rail F of the frame beneath the axis; and after passing through one of the holes in the above plate *e*, and turning over a round wooden rod G, has a lead weight suspended to the other end of it. These weights are shewn at *bb*. The rods G G are suspended by strings at their ends from the ceiling of the room. To each of the above cords another is tied just before it passes over G. These are represented by H, and hang loosely. The upper ends of these cords are tied to horizontal cords extended across the ceiling of the room, and made fast to the ceiling at one end; the other ends pass over pulleys situated at the top of the loom, in a frame called the table of mullets, and the harness or heddles are suspended by them.

By this arrangement it will be seen, that when any one of the cords fastened at F is pulled down, it must draw one of the strings H, and raise such an arrangement of the harness or heddles as is proper to produce the figure which is to be woven. The weight *b* draws the cord so as to keep it straight; all that is therefore necessary is to draw down the cords at F one at a time, but to take a different one each time, and thus raise a different series of the heddles each time; this is the business of the machine, and which it accomplishes in the following manner.

The bar, or axis, A A, has an iron femicircle, *d*, grooved like a pulley, and each of its ends divided, so as to form a cleft-hook or claw.

Each of the strings made fast at F has a large knot tied in it, just beneath where it passes through the brass plate *ee*, and which knot stops the farther ascent of the cord, in consequence of the pull of the weight *b*. Now when the axis A vibrates backwards and forwards by the treadles of the loom, as before mentioned, the hook of the femicircle *d* seizes the knot of one of the cords F, and draws down that cord, and raises the heddles belonging to it. The weaver throws the shuttle, and then returns the treadles, and the axis A with the femicircle returns back again, and allows the cord F to take its original position. When the femicircle *d* inclines over to the other side, its opposite hook

takes hold of the cord F, which is next to the one opposite to that which it just quitted; it draws down this cord, and the weaver again throws his shuttle, then returns the femicircle to the opposite side, and it will take the cord next to the opposite one, and so on; so that the femicircle will in succession take every alternate cord in each of the rows *ee*, and leave every other.

This is effected by the femicircle sliding along its axis A every time, by means of two wooden racks, *b* and *i*, in the plan, which are let into grooves in the axis A; these racks have teeth like saws, but inclined in contrary directions. The racks move backwards and forwards in their grooves, the extent of a tooth at each vibration of the axis, by the action of two circular inclined planes of iron fastened to the frame at L M, against which the ends of the racks are thrown by spiral springs concealed beneath each rack. The femicircle is fixed on a box or carriage N, which slides upon the axis A, and has two clicks upon it; one at *l*, which falls into the teeth of the rack *b*; the other at *m* for the rack *i*: *n* is a roller fixed over the box, and connected with the two clicks *l* and *m*, by threads wound in opposite directions; so that one click is always raised up, and disengaged from its rack, while the other is in action. O is a piece of wire fixed to the frame, so as to intercept a small wire projecting from the roller when the axis is inclined, and turn the roller a small quantity; P is another wire for the same purpose, but fixed to a cross bar, Q, which is moveable, and can be fastened at any required place, farther or nearer from the end of the axis. Suppose the roller *n* to be in such a position that the click *m* is down, and *l* drawn up, the action will be as follows: the femicircle first inclines to the direction of *fig. 2.*, its hook taking down one string; during this motion the end of the rack *i* comes to the inclined part of the circular inclined plane M, and moves by its spring towards D, the space of one tooth, which the click *m* falls into. On the return of the axis, the rack *i* is thrust back, and the box N and femicircle with it towards L, causing the hook to take the next opposite string: in this manner it proceeds, advancing a tooth each vibration, till it gets to the end of its course; the tail of the roller *n* then strikes against the pin P, and turns the roller over, raises the click *m*, and lets down the other, *l*, into the teeth of the rack *b*; this was all the time moving in a contrary direction to *i*, by its inclined plane L, but had no action, as its click *l* was drawn up; this being let down, the femicircle is moved back, a tooth at a time, towards M, until it meets O, which upsets the roller *n*, and sends the femicircle back again.

Tweeled Silks.—In weaving very fine silk tweels, such as those of sixteen leaves, the number of threads required to be drawn through each interval of the reed is so great, that if they were woven with a single reed, the threads would obstruct each other in rising and sinking, and the shed, or opening of the divided warp, would not be sufficiently open to allow the shuttle a free passage. To avoid this inconvenience, other reeds are placed behind that which strikes up the weft; and the warp-threads are so disposed, that those which pass through the same interval in the first reed are divided in passing through the second, and again in passing through the third. By these means the obstruction, if not entirely removed, is greatly lessened.

In the weaving of plain thick woollen cloths, to prevent obstructions of this kind arising from the closeness and roughness of the threads, only one-fourth of the warp is sunk and raised by one treadle, and a second is pressed down to complete the shed between the times when every shot of weft is thrown across.

Double Cloth is composed of two webs, each of which consists

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consists of separate warps and separate wefts, but the two are interwoven at intervals. The junction of the two webs is formed by passing each of them occasionally through the other, so that any particular part of both warps will be found sometimes above and sometimes below.

This species of weaving is almost exclusively confined to the manufacture of carpets in this country. The material employed is dyed woollen, and as almost all carpets are decorated with fanciful ornaments, the colours of the two webs are different, and they are made to pass through each other at such intervals as will form the patterns required. Hence it happens that the patterns at each side of the carpet are the same, but the colours are reversed. Carpets are usually woven in the draw-loom, or with the machine called the draw-boy before described.

Marfeilles is a fabric woven of cotton, which is a double cloth. The loom for weaving *Marfeilles* is somewhat similar to the diaper loom. A good idea of the manner in which it is prepared may be had, by conceiving two webs woven one under the other in the same loom, which are made to intermingle at all the depressed lines, and form the reticulations on the surface, in imitation of the quilting performed by hand.

When the species of *Marfeilles*, called *Marfeilles* quilting, is made, a third warp, of softer materials than the two others described, lies between them, and merely serves as a sort of stuffing to the hollow squares formed by them.

Quilting is another sort of cotton stuff, solely appropriated to quilts, which should, in strictness, be set down exclusively to the cotton manufacture, although there is nothing to prevent its being made of other materials.

The weft of those quilts is of very coarse and thick yarn, which is drawn out by a small hook into little loops, as it is woven, that are so arranged as altogether to form a regular pattern; every third or fourth shoot of the shuttle, the weaver has to stop to form those loops from a draft, which causes the weaving of those quilts to take up more time than that of any other stuff, except tapestry; which accounts for the greatness of the price at which they are sold, in proportion to the value of the materials of which they are principally composed.

Gauze differs in its formation from other cloths, by having the threads of the warp crossed over each other, instead of lying parallel. They are turned to the right and left alternately, and each shot of weft preserves the twine which it has received.

This effect is caused by a singular mode of producing the sheds, which cannot easily be described without the aid of drawings.

Cross, or *Net Weaving*, is a separate branch of the art, and requires a loom particularly constructed for the purpose.

Spots, brocades, and lappets, are produced by a combination of the arts of plain, tweeled, and gauze weaving, and as in every other branch of the art are produced in all their varieties by different ways of forming the division of the warp by the application of numerous heddles, and their connections with the treadles which move them. Indeed the great skill of the art consists in the proper management of this part of the apparatus of a loom.

Ribband Weaving.—This was formerly performed by a small common loom, weaving one ribband at a time. Ribbands are commonly striped in the length by laying a striped warp, and patterns are produced by changing the colour of the weft occasionally; sometimes an ornamented edging is formed by a succession of open loops at the borders of the ribband. Figured ribbands are also woven by a great number of treadles, but as they rarely extend to a greater number

than the weaver can manage by his feet, they seldom employ a draw-loom.

Engine-Loom for weaving Ribbands.—The weavers at Coventry, which is the principal seat of the ribband trade, universally employ what they call an engine-loom: it is worked by the hands and feet like a common loom, but weaves twelve, sixteen, or even twenty ribbands at once. The shuttles are of course fly-shuttles, and are driven by what is called a ladder, because it is a small frame exactly like a ladder, which slides horizontally in a groove in the lay; and every cross-bar of the ladder acts upon one shuttle in the manner of a pecker: the ladder has a handle to give it motion.

Another peculiarity of this loom is, that the ribbands are taken away as they are woven, with very few interruptions to wind up the work: for this purpose they conduct the warps over pulleys, and the ribbands also, so that both hang down in long loops. These looped parts are conducted through pulleys, which are loaded with weights, and tend always to draw the loops down, and keep the warp tight. The weight which is thus suspended by the finished ribband tends to draw it forwards at every stroke which the lay makes; and the weight which is suspended by the yarn of the warp is drawn up. When these weights have run through their respective courses, the weaver must stop to wind up the finished ribband, and unwind a fresh length of yarn. In some looms this is rendered unnecessary by a simple mechanism, which continually winds up the ribband as fast as it is woven.

In 1801 the Society of Arts rewarded Mr. Thomas Clulow, for an improved loom for weaving figured ribbands.

This loom differs from the common figured ribband-looms in the method of forming the figure, which, in the old mode, was tedious, from the work being stopped, whilst the figure was drawn by hand.

In the present loom, the tire-cords which form the figure are drawn or worked by a cord or leather-strap fixed to the centre-treadle, which strap passes over two vertical and one horizontal pulley to the back of the loom, and has a weight hung to the end thereof. Upon this strap above the weight is fixed an iron, of a bevel or sloping form, which when the strap is pulled up by pressing with the foot upon the treadle, raises a wire-lever placed across the main-wheel of the movements placed vertically, and allows this main-wheel to move one-fourth of its circumference, where it is stopped by an iron pin, placed on its rim, and prevented from returning by a clitch or catch on the edge of the wheel on its right side.

Within the rim of the main-wheel is a small catch-strap connected with the strap above-mentioned; this catch-strap pulls forward the main-wheel one-fourth of its circumference, until it is stopped by the wire-lever and one of the pins on the rim, of which there are four in number in the ground.

There are also four iron pins projecting from the left side of the main-wheel in opposite quarters of it: these act on a hanging lever, to the lower part of which a string is attached, which passes behind the box containing the whole machinery, and raises four clicks or catches on four rollers, which permits any one of the four rollers to run back as the figure may require, each roller by such motion drawing up the number of threads necessary to form the figure, by cords extending from these rollers over pulleys to the pass-cords, which draw the figure.

Machine Loom for Ribbands.—We have before mentioned M. Vaucanson's loom for weaving ten ribbands by a rotatory motion. We do not know that this is in use in this country.

Mr. James Birch invented an improvement on the swivel-loom, so as to weave satin-guard or figured laces, and received a reward from the Society of Arts in 1804.

This loom is worked by a circular motion of the hands, without treadles, or any application of the feet.

A wooden bar, to which the hands are applied, works two cranks on a large iron axle, extending the width of the loom; one crank is near each end of the above axis. A fly-wheel is attached to one of the ends of the axis, to regulate the motion of the machinery; an endless screw is placed upon the axis, works a star-wheel underneath it, which turns a barrel that has a resemblance to that of a hand-organ, and has wooden pegs fixed in different parts around it: these pegs catch upon levers, which draw forward the cords that form the figure, and pull them down by a claw, which secures the cords thus brought within its power, and by those means raise the upper gear connected with the cords.

In this loom fourteen pieces of satin-guard or bed-lace are wove at the same time, either one pattern and breadth, or all of different patterns and breadths, as may be required. The figure may be extended to any number of shoots desired.

The loom takes up no more space than a common swivel-loom, such as is employed in plain-work. It appears to work with ease and expedition, to make good work, and to be easily managed. It does not break or chafe the silk during its working. The weaver can move to any part of the front of the loom to inspect the work, and to continue the motion during that time; and the figure or pattern may be formed double the length of those usually done in the engine-loom. The loom can be stopped when required, at any one shoot of the shuttle; and it will answer to weave articles made of silk, wool, cotton, or linen, or mixtures of those articles, or gold or silver lace, and performs its work in half the time of an engine-loom.

The want of uniformity in the technical phraseology of the art of weaving, and the intricacy of the subject, have compelled us to render our descriptions far more intricate and difficult than they otherwise would have been.

We must acknowledge the assistance which we have derived from the very excellent "Essays on the Art of Weaving," by Mr. Duncan, 1808, in 2 vols. 8vo. It is a most curious and valuable publication, embracing almost every thing necessary to be known concerning the art on which it professes to treat; if we except some of the recent improvements in machine-weaving, which are only slightly noticed.

The French have long excelled in the various branches of figure-weaving; but this is more from dexterity of their weavers than from their machinery. Descriptions and drawings of all looms used by them, with every detail of their structure, will be found in the different articles of L'Encyclopede Methodique, and Les Arts et Metiers, D'Art de Fabriquer le Soie, &c.

WEAVING of Cloth, Cotton, and Silk. See WEAVING *supra*.

WEAVING of Tapestry, &c. See TAPESTRY, &c.

WEAVING, Stocking. See STOCKINGS.

WEAUME, in *Geography*, a river of France, which runs into the sea, near Marfeilles.

WEAUS, or WEEAS, Indians dwelling near the head of the river Wabash.

WEAUTENANS, Indians of North America, about N. lat. 40° 20'. W. long. 87° 20'.

WEB, a fort of plexus, or texture, formed of threads interwoven with each other; some of which are extended in

length, and called the *warp*, and others drawn across them, called the *woof* or *west*. See WEAVING *supra*.

WEB is also a technical term for all weavers and bleachers, both in Great Britain and Ireland, for a piece of linen cloth.

WEB, *Spider's*, or *Cob-Web*, is a very delicate and wonderful plexus, which that insect spins out of its own bowels; serving it as a sort of toil, or net, to catch flies, &c. See SPIDER.

For the manner in which the spider spins his web, the admirable mechanism of the parts subservient to it, and the uses of it, see SILK, and *Duility of Spider-WEBS infra*.

Dr. Lister tells us, that, attending nearly to a spider weaving a net, he observed it suddenly to desist in the mid-work; and turning its tail to the wind, it darted out a thread, with the violence and stream we see water spout out of a jet: this thread, taken up by the wind, was immediately carried to some fathoms long; still issuing out of the belly of the animal. By-and-bye the spider leaped into the air, and the thread mounted her up swiftly. After this discovery he made the like observation in near thirty different sorts of spiders, and found the air filled with young and old, sailing on their threads, and doubtless seizing gnats and other insects in their passage: there being often manifest signs of slaughter, legs and wings of flies, &c. on these threads, as well as in their webs below.

Dr. Hulse discovered the same thing about the same time. In a letter of Dr. Lister to Mr. Ray, he thinks there is a fair hint of the darting of spiders in Aristotle, Hist. An. lib. ix. cap. 30. and in Pliny, lib. x. cap. 74. But with regard to their sailing, the ancients are silent, and he thinks it was first seen by him. In another letter to Mr. Ray, dated January, 1670, speaking of the height spiders are able to fly to, he says, "Last October, &c. I took notice that the air was very full of webs; I forthwith mounted to the top of the highest steeple on the minster (in York), and could there discern them yet exceeding high above me."

Duility of Spider-WEBS. M. Reaumur observes, that the matter of which spiders and silk-worms form their threads, is brittle when in the mass, like dry gums. As it is drawn out of their bodies, it assumes a consistence, much as glass-threads become hard, as they recede from the lamp, though from a different cause. The duility of this matter, and the apparatus for this purpose, being much more extraordinary in spiders than in silk-worms, we shall here only consider the former. Something also has already been said of each under SILK.

Near the anus of the spider are five or six papillæ, or teats. The extremities of the several papillæ are furnished with holes, that do the business of wire-drawers, in forming the threads. Of these holes, M. Reaumur observes, there are enough in compass of the smallest pin's-head, to yield a prodigious quantity of distinct threads. The holes are perceived by their effects: take a large garden-spider ready to lay its eggs, and applying the finger on a part of its papillæ, as you withdraw that finger, it will take with it an amazing number of different threads. M. Reaumur has often counted seventy or eighty with a microscope, but has perceived that there were infinitely more than he could tell. In effect, if he could say, that each tip of a papilla furnished a thousand, he is persuaded he should say much too little. The part is divided into an infinity of little prominences, like the eyes of a butterfly, &c. each prominence, no doubt, makes its several threads; or rather, between the several protuberances, there are holes that give vent to threads; the use of the protuberances, in all probability,

bility, being to keep the threads at their first exit, before they are yet hardened by the air, asunder. In some spiders those protuberances are not so sensible; but in lieu thereof there are tufts of hair, which may serve the same office, *viz.* to keep the threads apart. Be this as it will, there may threads come out at above a thousand different places in every papilla; consequently, the spider having six papillæ, has holes for above six thousand threads. It is not enough that these apertures are immensely small: but the threads are already formed before they arrive at the papilla, each of them having its little sheath or duct, in which it is brought to the papilla from a considerable distance.

M. Reaumur traces them up to their source, and shews the mechanism with which they are made. Near the origin of the belly he finds two little soft bodies, which are the first source of the silk. Their form and transparency resemble those of glass-beads, by which name we shall hereafter denote them. The tip of each bead goes winding, and makes an infinity of turns and returns towards the papilla. From the base, or root of the head, proceeds another branch much thicker; which winding variously, forms several knots, and takes its course like the other, towards the hind part of the spider. In these beads and their branches, is contained a matter proper to form the silk, only that it is too soft. The body of the bead is a kind of reservoir, and the two branches two canals proceeding from it. A little farther backwards, there are two other lesser beads, which only send forth one branch a-piece, and that from the tip. Beside these, there are three other larger vessels on each side of the spider, which M. Reaumur takes for the last reservoirs, where the liquor is collected. The biggest is near the head of the insect, and the least near the anus. They all terminate in a point; and from the three points of these three reservoirs it is, that the threads, at least the greatest part of the threads drawn out at the three papillæ, proceed. Each reservoir supplies one papilla. Lastly, at the roots of the papillæ, there are discerned several fleshy tubes; probably, as many as there are papillæ. Upon lifting up the membrane, or pellicle, that seems to cover these tubes, they appear full of threads, all distinct from each other, and which, of consequence, under a common cover, have each their particular one; being kept like knives in sheaths. The immense quantity of threads contained here, M. Reaumur concludes, upon tracing their course, does not wholly come from the points of the reservoirs; but some from all the turns, and angles; nay, probably from every part of it. But by what conveyances the liquor comes into the beads, and out of the beads into the reservoirs, remains yet to be discovered.

We have already observed, that the tip of each papilla may give passage to above a thousand threads; yet the diameter of that papilla does not exceed a small pin's-head; but we were there only considering the largest spiders.

If we examine the young growing spiders produced by those, we shall find, that they no sooner quit their egg, than they begin to spin. Indeed their threads can scarce be perceived; but the webs may: they are frequently as thick, and close, as those of house-spiders; and no wonder: there being often four or five hundred little spiders concurring to the same work. How minute must their holes be? the imagination can scarce conceive that of their papillæ! The whole spider is, perhaps, less than a papilla of the parent which produced it.

This is easily seen; each big spider lays four or five hundred eggs; these eggs are all wrapped up in a bag; and as

soon as the young ones have broke through the bag, they begin to spin. How fine must their threads at this time be!

Yet is not this the utmost nature does: there are some kinds of spiders so small at their birth, that they are not visible without a microscope. There is usually found an infinity of these in a cluster, and they only appear like a number of red points. And yet there are webs found under them, though well nigh imperceptible. What must be the tenuity of one of these threads; the smallest hair must be to one of these what the most massive bar is to the finest gold-wire.

The matter of which the threads are formed, we have observed, is a viscid juice. The beads are the first receptacles where it is gathered, and the place where it has the least consistence. It is much harder when got into the six great reservoirs, whither it is carried by canals from the former; this consistence it acquires in good measure in its passage; part of the humidity being dissipated in the way, or secreted by parts destined for that purpose.

Lastly, the liquor is dried still farther, and becomes thread, in its progress through the respective canals to the papillæ. When these first appear out at the holes, they are still glutinous; so that such as spring out of neighbouring holes stick together. The air completes the drying.

By boiling the spider, more or less, the liquor is brought to a greater or less consistence, fit to draw out into threads; for it is too fluid for that purpose while yet inclosed in its reservoirs.

The matter contained in these reservoirs, when well dried, appears a transparent gum, or glue, which breaks when much bent: like glass, it only becomes flexible by being divided into the finest threads. And probably it was on this account nature made the number of holes so immense. The matter of silk formed in the bodies of spiders being much more brittle than that formed in silk-worms, needed to be wound smaller. Otherwise we do not conceive, why they should form a great number of threads, which were afterwards to be re-united: a single canal might else have done.

The thread of a spider being strong enough to bear five or six times the weight of the spider's body, is composed of several finer threads, that are drawn out separately, but unite together at the distance of two or three hairs' breadth from the body of the spider. The threads are coarser or finer, according to the size of the spider that spins them. Mr. Leewenhoeck computes that 100 of the finest threads of a full grown spider, are not equal to the diameter of the hair of his beard; and consequently, if the hair be round, 10,000 such threads are not bigger than such a hair. He calculated farther, that when young spiders first begin to spin, 400 of them are not larger than one that is full-grown; and therefore the thread of such a little spider is 400 times smaller than the thread of a full-grown one; allowing this, four millions of a young spider's threads are not so big as the single hair of a man's beard.

WEB, in *Ship-Building*, the thin partition on the inside of the rim, and between the spokes of an iron or brass-sheave.

WEB of a *Coulter*, in *Agriculture*, that part of it which is drawn out thin and sharp, in order to cut and separate the ground, in opposition to the others which are thick and blunt. In the sock, too, any thin sharp part has the name of web or wing.

WEB on the *Eye*, among *Animals*, a term sometimes used to signify a film on that part. See EYE, FILM, and *White FILM*.

WEB-Cafe. See CHRYSALIS.

WEB, Pin and. See PANNUS.

WEBB, PHILIP-CARTERET, in *Biography*, a member of the society of antiquaries, was born in 1700, and admitted an attorney in 1724, and distinguished for his acquaintance with the records of the kingdom, and with constitutional and parliamentary law. He was returned in 1754, and again in 1761, as a member for the borough of Haslemere; and being attached to the then existing administration, he obtained the place of secretary of bankrupts in the court of chancery, and in 1756 became one of the joint solicitors of the treasury. He was employed in 1763 in conducting the prosecution against Mr. Wilkes, for writing a number of the North Briton; and printed on that occasion "A Collection of Records about General Warrants," and "Observations on discharging Mr. Wilkes from the Tower." He died at his house in Busbridge, Surrey, in June 1770, and left a valuable library, and curious collection of coins, medals, and relics of antiquity, which were sold by auction. He had sold 30 MSS. of the rolls of parliament to the house of lords, and a number of other MSS. were sold to lord Shelburne, and afterwards to the British Museum. Among his publications we may reckon "A Letter to the Rev. Mr. Warburton, on some passages of his Divine Legation;" "Various Pieces relative to the State of the Law in this Kingdom;" "Account of some Particulars concerning Domesday Book;" "A short Account of Danegeld;" "Account of a Copper Table, discovered near Heraclea." Mr. Webb was twice married, and by his first wife left a son of his own name. Nichols's Lit. Anecd. Gen. Biog.

WEBB Pond, in *Geography*, a town of the district of Maine, in the county of Oxford, containing 318 inhabitants.

WEBBER, JOHN, in *Biography*, who accompanied captain Cook in his last voyage to the South sea, in the capacity of draughtsman, was a native of London, though his father was a Swiss. He was born in 1752, and was sent young to Paris for his education as an artist. After his return he studied at the Royal Academy, of which in 1785 he became a member. His talents for drawing landscape recommended him to the lords of the admiralty, who appointed him to go with captain Cook on his voyage of discovery; and when the vessels returned in 1780, they also commissioned him to superintend the engraving of the prints from his own drawings of the scenes he had beheld. When these were completed, he was permitted to publish a work consisting of other views which he had made, which he etched and aquatinted himself, and published on his own account; and these produced him a handsome remuneration. He afterwards applied himself to painting, but his pictures are weak and unsubstantial, without colour or effect, or any great degree of merit, though they please from their neatness and minuteness. He died in 1793, aged 41.

WEBERA, in *Botany*, owes its name to Schreber, who dedicated this genus to the memory of George Henry Weber, late professor of medicine and botany at Kiel; an excellent cryptogamic botanist, most celebrated for his *Spicilegium Floræ Goettingensis*, published in 1778, and one of the classical books in that department of the science. He died in 1786, at the age of 35. Hedwig had previously commemorated Weber in a genus of Mosses, some species of which are now referred to *Bartramia*, others to *Bryum*. (See MUSCI and FRINGE of Mosses.) It is to be regretted that *Webera* did not take place of *Bartramia*, the person after whom the latter was named, however meritorious, being scarcely at all conversant with mosses.—Schreb. Gen. 794.

Willd. Sp. Pl. v. 1. 1224. Mart. Mill. Dict. v. 4. Ait. Hort. Kew. v. 1. 371. (Chomelia; Linn. Gen. ed. 2. 72.) Class and order, *Pentandria Monogynia*. Nat. Ord. *Rubiaceæ*, Juss.

Gen. Ch. Cal. Perianth superior, of one leaf, divided half way down into five erect, acute, permanent segments. Cor. of one petal, funnel-shaped; tube cylindrical, longer than the calyx: limb in five ovate-oblong, reflexed segments. Nectary a fleshy ring, surrounding the base of the style. Stam. Filaments five, very short, inserted into the margin of the tube; anthers linear, incumbent, spreading. Pist. Germen roundish, inferior; style simple, longer than the tube of the corolla; stigma club-shaped, with ten furrows. Peric. Berry nearly globular, of two cells, crowned with the permanent enlarged calyx. Seeds from two to four in each cell, angular.

Ess. Ch. Calyx superior, in five permanent segments. Corolla funnel-shaped, five-cleft. Stamens in the mouth of the tube. Stigma club-shaped, with ten furrows. Berry inferior, of two cells. Seeds several, angular.

A genus of evergreen East Indian shrubs, with opposite branches and leaves; and axillary or terminal, aggregate flowers, which are occasionally augmented in the number of their divisions and stamens, from five to six. *Canthium* of Lamarck's Dict. v. 1. 602. Juss. 204. Cavan. Ic. v. 5. 21, confounded by Willdenow with this genus, is certainly very distinct in its habit, peltate stigma, solitary seeds, and four-cleft flowers.

1. *W. corymbosa*. Corymbose *Webera*. Willd. n. 1. Ait. n. 1. (*Rondeletia asiatica*; Linn. Sp. Pl. 244. Cupi; Rheede Hort. Malab. v. 2. 37. t. 23. Raii Hist. v. 2. 1494.)

Leaves elliptic-oblong. Corymb terminal, forked, many-flowered.—Native of sandy ground in the East Indies; cultivated by Miller in the stove at Chelsea, in 1759, but it is not recorded by Mr. Aiton to have flowered, nor do we recollect having ever seen the plant in any collection. A wild specimen from Dr. Rottler is before us. The stem is shrubby, about the height of a man, with smooth, leafy, somewhat compressed, branches. Leaves on short thick stalks, entire, coriaceous, very smooth, four inches long, rather acute, with a stout rib, and numerous reticulated veins; their upper side shining; lower paler. Stipules intrafoliaceous, triangular, short, pointed. Flower-stalks hairy. Flowers three-quarters of an inch long, whitish, agreeably fragrant, turning yellowish as they fade. Berries firm, the size of a currant, blackish, sweetish, but not eatable. Rheede describes 7 or 8 seeds in each fruit.

This plant has the appearance of an *Ixora* or *Pavetta*, as we have observed at the end of our article RONDELETIA; but perhaps the stigma, very important in this natural order, may keep it distinct.

2. *W. cymosa*. Cymose *Webera*. Willd. n. 2.—"Leaves ovate, pointed. Cymes axillary, stalked, many-flowered."—Native of the East Indies. "A tree, with round downy branches. Leaves stalked, ovate, obtuse with a point, entire, very smooth, rigid, simply veiny; shining above. Cymes convex. Flower-stalks downy. Corolla half the size of the former. Style much longer than the corolla. Stigma capitate, cloven. Berry the size of Juniper."—Willdenow, from a dried specimen.—We have not seen this species. The description of the stigma does not answer to the generic character.

WEBHAMET, in *Geography*, a river of the district of Maine, which runs into the Atlantic, near Wells.

WEBUCH,

WEBUCH, CAPE, a cape on the E. coast of Labrador. N. lat. $55^{\circ} 21'$. W. long. $58^{\circ} 10'$.

WECHMAR, or WARIHMAR, a town of Germany, in the principality of Gotha; 4 miles S.E. of Gotha.

WECHQUETANK, a Moravian settlement in Pennsylvania; 30 miles N.W. of Bethlehem.

WECHSELBURG, a township of Germany, in the lordship of Schonburg; 4 miles N.N.E. of Penig.

WECHSTEN, a town of Germany, in the county of Verden; 12 miles S.E. of Verden.

WECHTERBACH, a town of Germany, in the county of Isenburg; 7 miles S.E. of Budingem.

WECHTERSWINCKEL, a town of the duchy of Wurzburg; 3 miles N.N.W. of Neustadt am Saal.

WECKHOLM, a town of Sweden, in the province of Upland; 22 miles S.W. of Upsal.

WED EL CASAAB, a river of Algiers, which runs into the Mediterranean, 5 miles S. of Cape Falcon.

WED el Kibbeer, a river of Algiers, anciently called *Ampfaga*, which runs into the Mediterranean, 15 miles S. of Sebba Rous. N. lat. $36^{\circ} 57'$. E. long. $6^{\circ} 28'$.

WED el Mailab, i. e. the *Salt River*, a river of Algiers, which runs into the Mediterranean, 10 miles S.S.E. of Cape Figalo.

WED el Shaier, a river of Africa, which rises about 12 miles E. from the mountain of Zeckar, in the Sahara, and after a north-east course about 30 miles changes its name to Mailah, and finally loses itself in the Short.

WEDDER, the name of a certain state of sheep. See WETHER-Sheep.

WEDDRA, in *Commerce*. See VEDRO.

WEDEKINSTEIN, in *Geography*, a town of Westphalia, in the principality of Minden; 3 miles S.W. of Minden.

WEDEL, GEORGE WOLFFGANG, in *Biography*, an eminent physician, was born in 1645, at Golzan, in Lusatia, and studied physic and took his doctor's degree at Jena, in 1667, where, after a temporary exercise of his profession at Gotha, he became medical professor, in which station he continued with reputation for almost fifty years. He combined with his medical skill a considerable acquaintance with mathematics and philology, as well as with the oriental and classical languages. He was an associate to the Academy Naturæ Curiosorum, and to the Royal Society of Berlin, physician to several German sovereigns, a count palatine, and an imperial counsellor. Notwithstanding these high offices and numerous engagements, he was attentive to the poor, and assiduous in his literary labours. His pathology was derived from the systems of Helmont and Sylvius; in his practice he depended much on absorbents, and the volatile salts of vegetables. Wedel was addicted to astrology; but he is chiefly celebrated for his pharmaceutical knowledge, and his elegance of prescription, so that many of his compositions have been adopted in dispensaries. Of his works, besides his academical dissertations, the principal are the following; viz. "Opiologia;" "Pharmacia in Artis formam redacta;" "De Medicamentorum Facultatibus cognoscendis et applicandis;" "De Morbis Infantum;" and "Exercitationes Medico-Philologicae." Haller. Eloy.

WEDEL, in *Geography*, a town of Holstein; 13 miles N.W. of Hamburg.—Also, a town of the New Mark of Brandenburg; 11 miles E. of Reetz.

WEDELIA, in *Botany*, was so called by Jacquin, in honour of Dr. John Wolfgang Wedel, of Jena, whom he celebrates as a highly meritorious botanist, and who wrote a *Tentamen Botanicum*, published at Jena in 1747, with a preface by his friend Hamberger. The design of this

work is to combine the systems of Rivinus and Linnaeus, the classes of the latter making subdivisions of the former. We presume that no scheme could be less natural or useful, whatever the botanical skill of the author might be; of which indeed we are not disposed to think highly, as he made a point of excluding the fruit from his principles of classification. He wrote a German essay against Haller, on the subject of botanical terms, of which the latter speaks as full of taunts and reproaches. Wedel died in 1757, at the age of 49. Some others of the same name, and probably the same family, who were Professors at Jena, appear full as well entitled to botanical honours; especially George Wolfgang Wedel, who died in 1721, aged 76, and has left behind him numerous dissertations on botany and the materia medica.—Jacq. Amer. 217. Willd. Sp. Pl. v. 3. 2334. Juss. 189. Gært. v. 2. 435. (Alcina; Cavan. Ic. v. 1. 10. Ait. Hort. Kew. v. 5. 164.)—Class and Order, *Syngenesia Polygamia-necessaria*. Nat. Ord. *Compositæ oppositifoliae*, Linn. *Corymbiferae*, Juss.

Gen. Ch. *Common Calyx* simple, of four or five large leaves. *Cor.* compound, radiant. *Florets* of the disk perfect, numerous, funnel-shaped, five-cleft; those of the radius from eight to twelve, roundish-ovate, cloven. *Stam.* in the florets of the disk. Filaments five, capillary short; anthers united into a tube, as long as the partial corolla. *Pist.* in the same florets, Germen minute, imperfect; style thread-shaped, the length of the anthers; stigma simple or divided: in those of the radius, Germen oblong, quadrangular; style thread-shaped; stigmas two, revolute. *Peric.* none, the calyx remaining unaltered. *Seeds* in the disk imperfect; in the florets of the radius solitary, obovate, gibbous, crowned with four, five, or ten teeth. *Recept.* chaffy, slightly convex; the scales ovate, concave, as long as the florets.

Ess. Ch. Receptacle chaffy. Seed-crown of from five to ten teeth. Calyx simple, of four or five leaves.

Obf. This genus is separated from POLYMNIA, (see that article,) on account of its simple calyx, and the presence of a crown to the seeds, which appear to us sufficient characters.

1. *W. frutescens*. Shrubby *Wedelia*. Willd. n. 1. Jacq. Amer. 217. t. 130. (Polymnia *Wedelia*; Linn. Mant. 118. Poir. in Lam. Dict. v. 5. 506.)—Stem shrubby. Leaves distinct, stalked, lanceolate. Seed-crown of ten teeth.—Native of Carthage, South America, in bushy woody places, flowering in July and August. *Stem* shrubby, climbing, with round leafy branches, rough in our specimen with minute points. *Leaves* acute, two or three inches long, somewhat ferrated, bristly on both sides; the upper rough with callous points; lower paler. *Foot-stalks* linear rough, hardly half an inch in length, combined at the base by a narrow annular *stipula*. *Flowers* terminal, stalked, solitary, yellow, near an inch broad, with a rough *calyx*; the outer scales of their *receptacle* looking like a coloured inner calyx. *Seeds*, according to Jacquin, each with a little cup-shaped crown, having about ten teeth.

2. *W. perfoliata*. Perfoliate *Wedelia*. Willd. n. 2. (Alcina *perfoliata*; Cavan. Ic. v. 1. 11. t. 15. Ait. Hort. Kew. v. 5. 164.)—Stem herbaceous. Leaves rhomboid, tapering at the base, perfoliate. Seed-crown of five teeth.—Native of Mexico, from whence its seeds were brought to Madrid, and thence dispersed through the botanic gardens of other parts of Europe. This is an annual plant, with nothing to attract the attention of florists. It flowers late, and does not always ripen seed in England. The *stem* is four feet high, angular or furrowed, leafy, branched, nearly smooth, often purplish. *Leaves* three or four inches long,

long, including their narrow base, pointed, ferrated, triple-ribbed, light green, roughish. *Flowers* yellow, stalked, much smaller than the foregoing. *Calyx* broad, extending far beyond the rays. *Seeds* of the marginal *florets* large, tumid, each crowned with four, five, or more, irregularly placed tubercles, or teeth, not agreeing precisely with the crown of the first species, but scarcely affording sufficient reason to form a generic distinction.

WEDENSCHWEIL, in *Geography*, a town of Switzerland, and principal place of a bailiwick, in the canton of Zurich, on the S.W. coast of lake Zurich; 9 miles S. of Zurich.

WEDGE, CUNEUS, in *Mechanics*, the last of the five powers, or simple machines.

The wedge is a triangular prism, whose bases are isosceles acute-angled triangles.

Authors are divided about the principle whence the wedge derives its power.

Aristotle considers it as two levers of the first kind, inclined toward each other, and acting opposite ways. Guido Ubaldo, Merfennus, &c. will have them levers of the second kind. But Fr. de Lanis shews, that the wedge cannot be reduced to any lever at all.

Others refer the wedge to the inclined plane. Others, again, with De Stair, deny the wedge to have scarce any force at all; and ascribe much the greatest part to the matter that drives it.

Its doctrine (according to some writers) is contained in this proposition. "If a power be applied to a wedge, in such manner, as that the line of direction CD (*Plate XL. Mechanics, fig. 1.*) perpendicular to AB , is to the resistance to be overcome, as AB to CD ; the power will be equal to the resistance."

Or thus: "If the power directly applied to the head of the wedge, be to the resistance to be overcome by the wedge, as the thickness of the wedge is to its height; then the power will be equivalent to its resistance; and, if increased, will overcome it."

In proof of this proposition, they allege, that the firmness by which the parts of the obstacle, suppose wood, adhere to one another, is the resistance to be overcome by the wedge; and that while the wedge is driven into the wood, the way or length it has gone is BH (*fig. 2.*); and DC is the way or length gone in the same time, by the impediment; that is, the parts C and D of the wood are so far divided asunder: and according as the wedge is driven down farther and farther along its height; so the parts C and D of the wood are divided more and more, along the thickness of the wedge.

But Dr. Defaguliers has proved, that, when the resistance acts perpendicularly against the sides of the wedge, the power is to the whole resistance as the length of both sides of the wedge, taken together, is to the thickness of its back.

According to the preceding theory, if the thickness of the wedge (that is, the way of the impediment, and consequently its velocity) be to the height of the wedge (that is, the way, and consequently the velocity of the power) as the power to the impediment, or resistance; then the momentum of the power, and the impediment, will be equal the one to the other: and consequently the power, being increased, will overcome the resistance.

Hence, 1. The power equivalent to half the resistance, is to it as AC to DC , (*fig. 1.*) that is, as the whole sine to the co-tangent of half the angle of the wedge ADC . And 2. As the tangent of a less angle is less than that of a greater, the power must have a greater proportion to half

the resistance, if the angle be greater than if less; consequently, the acuter the wedge is, the more does it increase the power.

The above proportion is adopted by Wallis, (*Op. Math. vol. i. p. 1016.*) Keil, (*Int. ad Ver. Phyl.*) and S'Gravesande (*El. Math. lib. i. cap. 14.*); but S'Gravesande, in his *Scholium de ligno findendo* (*ubi supra*), observes, that when the parts of the wood are separated before the wedge, the force by which it is thrust in is to the resistance of the wood as a line, drawn from a point in the middle of the base to the side of the wedge, and at right angles with the side of the separated wood continued, to the height of the wedge; but when the parts of the wood are separated no farther than the wedge is driven in, the equilibrium will be, when the power is to the resistance as the half base of the wedge to its side.

To this method of estimating the power of the wedge it has been objected that, by allowing each part of the weight to have moved through a space equal to half the back of the wedge, whilst the power has moved through its height, and the whole weight to have moved through a space equal to the whole back, the whole is made to move farther than its parts.

M. Muschenbroeck states the proportion of the power to the weight in a simple wedge, or half the wedge (*fig. 1.*) bisecting it by a plane passing through CD , as its back is to its length, or in that case as AC to CD : and in a double wedge or the wedge ABD , as AB to $2CD$. *Int. ad Phil. vol. i. p. 132.*

Mr. Ferguson estimates the power of the wedge, in the two cases mentioned by S'Gravesande, in the following manner. When the wood does not cleave at any distance before the wedge, there will be an equilibrium (he says) between the power impelling the wedge downward, and the resistance of the wood acting against the two sides of the wedge, if the power be to the resistance as half the thickness of the wedge at its back is to the length of either of its sides; and if the power be increased so as to overcome the friction of the wedge, and the resistance arising from the cohesion or stickage of the wood, the wedge will be drove in, and the wood split asunder.

But when the wood cleaves at any distance before the wedge (as it generally does), the power impelling the wedge will be to the resistance of the wood as half its thickness is to the length of either side of the cleft, estimated from the top or acting part of the wedge: for supposing the wedge to be lengthened down to the bottom of the cleft, the power will be to the resistance as half the thickness of the wedge is to the length of either of its sides; or, which amounts to the same thing, as the whole thickness of the wedge is to the length of both its sides.

In proof of this proportion we may suppose the wedge divided lengthways into two equal parts, and then it will become two equally inclined planes; one of which, as abc (*fig. 3.*) may be made use of as a half-wedge for separating the moulding cd from the wainscot AB . When this has been driven its whole length ac between the wainscot and moulding, its side ac will be at ed , and the moulding will be separated to fg from the wainscot.

From the property of the inclined plane, it appears, that to have an equilibrium between the power impelling the half-wedge and the resistance of the moulding, the former must be to the latter, as ab to ac ; that is, as the thickness of the back which receives the stroke is to the length of the side against which the moulding acts. Consequently, since the power upon the half-wedge is to the resistance against its side, as the half back ab is to the whole side ac , it is plain,

plain, that the power upon the whole wedge (where the whole back is double the half back) must be to the resistance against both its sides, as the thickness of the whole back is to the length of both the sides, supposing the wedge at the bottom of the cleft; or as the thickness of the whole back to the length of both sides of the cleft, when the wood splits at any distance before the wedge. For when the wedge is driven quite into the wood, and the wood splits at ever so small a distance before its edge, the top of the wedge then becomes the acting part, because the wood does not touch it any where else. And since the bottom of the cleft must be considered as that part where the whole stickage or resistance is accumulated, it is plain from the nature of the lever, that the farther the power acts from the resistance, the greater is the advantage.

Some writers have, indeed, advanced, that the power of the wedge is to the resistance to be overcome, as the thickness of the back of the wedge is to the length only of one of its sides; but this, says Mr. Ferguson, seems very strange; for, if we suppose *AB* (*fig. 4.*) to be a strong inflexible bar of wood or iron fixed into the ground at *CB*, and *D* and *E* to be two blocks of marble lying on the ground on opposite sides of the bar; it is evident that the block *D* may be separated from the bar to the distance *d* equal to *ab*, by driving the inclined plane or half-wedge *abo* down between them; and the block *E* may be separated to an equal distance on the other side, in like manner, by the half-wedge *cdo*. But the power impelling each half-wedge will be to the resistance of the block against its side, as the thickness of that half-wedge is to the length of its acting side. Therefore the power to drive both the half-wedges is to the resistances, as both the half backs are to the length of both the acting sides, or as half the thickness of the whole back is to the length of either side. And, if the bar be taken away, the blocks put close together, and the two half-wedges joined to make one; it will require as much force to drive it down between the blocks, as is equal to the sum of the separate powers acting upon the half-wedges when the bar was between them. Ferguson's Lect. p. 40, &c. 4to. See also Defag. Exp. Phil. vol. i. p. 107, &c.

Mr. Ludlam, in an Essay on the Power of the Wedge, printed in 1770, proposes, with a particular view to the machines described by S'Gravesande, Defaguliers, and Ferguson, for estimating the power of the wedge, to determine this power, when two equal forces act on the sides of an isosceles triangle in directions parallel to the back but opposite to each other, and are sustained by a third force acting perpendicularly on the back of the wedge. For this purpose, let *ABC* (*fig. 5.*) be an isosceles wedge, whose angular point is *C*, sides *AC* and *BC*, back *AB*, and perpendicular height *HC*: let *FE* represent the quantity and direction of the force applied to one of the sides; this may be resolved into two other forces *FD* and *DE*, the former parallel and the latter perpendicular to the side *AC*; and the oblique force *FE* will have just the same effect upon the wedge as a less perpendicular force *DE*; the former being to the latter as *AC* is to *HC*. But this last perpendicular force on the side *AC* is to that on the back which balances it as *AC* is to *AH*; whence compounding these ratios, the oblique force against one side of the wedge is to the perpendicular force on the back which balances it, as *AC*² is to *AH* × *HC*. The oblique force *fe* on the other side of the wedge, being equal to *FE*, will require another perpendicular force on the back to balance it equal to the former perpendicular force; whence the whole force on both sides of the wedge is to the whole force on the back as *AC*² is to *AH* × *HC*; or as the square of the

side of the wedge to the rectangle under half the back and the perpendicular height.

For other methods of estimating the effect of the wedge in various cases, see *MECHANICAL Powers*.

The wedge is a very great mechanical power, since not only wood but even rocks can be split by it; which it would be impossible to effect by the lever, wheel and axle, or pulley; for the force of the blow or stroke, shakes the cohering parts, and thereby makes them separate the more easily.

To the wedge may be referred all edge-tools, and instruments which have a sharp point, in order to cut, cleave, slit, chop, pierce, bore, or the like; as knives, hatchets, swords, bodkins, &c.

WEDGE, in *Ship-Building*, a triangular solid made of wood or iron. It is one of the mechanic powers, the most simple, and of the greatest force.

WEDGE ISLAND, in *Geography*, a small island in the North Pacific ocean, near the E. coast of the Prince of Wales's Archipelago, in the Duke of Clarence's Strait. N. lat. 55° 8'. E. long. 228° 20'.

WEDGES, in *Agriculture*, are a sort of levers or distending powers that are of great use to the farmer on many occasions, as in tearing and splitting wood of all sorts, the roots of trees in taking them out of the ground, stones, and many other sorts of hard materials. About farm-houses of any extent, it is always of advantage to have a proper mallet and set of wedges for tearing up wood and other matters.

WEDGWOOD, *JOSIAS*, in *Biography*, was the younger son of a Staffordshire potter, and born in July 1730. His education was restricted, but his mental powers were of a superior kind, so that by the fixed and persevering exercise of them he made very considerable improvement in the art of pottery to which his attention was directed, and gave a name as well as reputation to the place of his nativity. (See *POTTERY* and *THE POTTERIES*.) His patrimony was small, but by his super-eminant skill and steady application he was the founder of his own fortune as well as fame. The principal feat of the potteries of Staffordshire was Burslem; and there is reason to believe that they have existed in or near this place for many centuries, and even, as some say, since the time of the Romans. But they had continued for a long time in the same rude state in which Plot found them when he surveyed this county. The merit of introducing into this country improvements in the art of pottery must be ascribed to two brothers of the name of Eders, who came hither from Holland about the year 1700, and settled in the neighbourhood of the Staffordshire potteries. They manufactured a red unglazed porcelain from a clay, which they found in the estate on which they settled, called "Bradwell;" but this was only the brown stone ware, in the composition of which no flint is used; but they made use of salt in glazing it: this salt, or muriate of soda, was thrown into the oven at a certain stage of the firing process, and the pieces of ware were so disposed as to receive the fumes of it on every part of their surfaces. The fumes, however, occasioned an alarm in the neighbourhood, which obliged them to leave the country. A similar manufactory, however, was soon after established at Shelton, in the Potteries, by one of their workmen, whose name was Astbury, and who had possessed himself of their secret; and as it was found very useful, it was tolerated by the inhabitants, though on the day of glazing, the dense offensive fumes from fifty or sixty manufactories filled the valleys, and covered the hills through an extent of several miles. The white stone ware,

and the use of ground flints in pottery, were introduced at a later period, and, as it is said, (see Parkes's Chem. Catechism,) in consequence of the following incident. About the year 1720, a potter, supposed to be the above-mentioned Astbury, stopped at Duntstable in his way to London, and sought a remedy for a disorder in his horse's eyes; and the oiler of the inn by burning a flint stone reduced it to a fine powder, which he blew into them. The potter, observing the beautiful white colour of the flint after calcination, instantly thought of applying the discovery to the improvement of his art, and afterwards introduced the white pipe-clays found on the south side of Devonshire, instead of the iron-clays of his own country, and thus produced the white stone ware. At first the flints were pulverized to the great injury of the persons employed; till the famous Brindley, in the early period of his life, constructed the mills that are now used for grinding them in a moist state. It is farther said, that an ingenious mechanic, named Alfager, afterwards improved the construction of the potter's wheel, so as to give much greater precision and neatness to the work. But still the French pottery exceeded in beauty that of Staffordshire; and about the year 1760, a considerable quantity of it was imported, and purchased by persons of opulence to the great detriment of the English manufacture. Mr. Wedgwood directed his attention to this article, and made several improvements with regard to the forms, colours, and composition of his manufacture; and in the year 1763 invented a kind of ware for the table, which gave a turn to the market, and under the name of queen's ware, conferred upon it in consequence of the patronage of her majesty, came into very general use. Its materials were the whitest clays from Devonshire and Dorsetshire, mixed with ground flint, and covered with a vitreous glaze. By varying and repeating his experiments, Mr. Wedgwood discovered the mode of manufacturing other species of earthenware and porcelain, excellent and beautiful, and adapted to various purposes both of use and ornament. With a view of prosecuting his improvement in pottery he applied to the study of chemistry, and for his farther assistance engaged the ingenious Mr. Chisholme, who had been employed in a similar department by the celebrated Dr. Lewis, author of the "Commercium Philosophico-Technicum;" for whom he not only built a comfortable habitation near the manufactory, but liberally afforded him an annuity for his support under the decays of age, which he continued till his death. Aided also by the classical taste of his partner, Mr. Bentley, potteries were furnished which served as models for various articles, formed of other materials, that were held in high estimation. We learn from Dr. Bancroft, that almost all the finely diversified colours which Mr. Wedgwood applied to his pottery were produced only by the oxyds of iron. In the manufacture of his beautiful jasper ware, which rivalled the productions of antiquity, and which found its way into the collections of the curious in all parts of Europe, he employed the native sulphate of barytes, and from this use of it he derived great profit, until by the infidelity of a servant the secret was disclosed and sold, so that others employed inferior workmen at a reduced salary, and thus prevented Mr. W. from employing his exquisite modellers on that branch of the manufacture.

Among other curious productions of this inventive manufacturer we may mention his imitation of the Barberini or Portland vase, which was discovered in the tomb of Alexander Severus, and for which the late dukes of Portland paid 1000 guineas. The subscription for Mr. W.'s manufacture was at the rate of 50*l.* each for fifty vases, but such were the expences of its execution, that the partners lost

money by the undertaking. Mr. Webber, it is said, received 500 guineas merely for modelling it. See VASE.

We cannot forbear in this connection noticing two cameos of Mr. Wedgwood's manufacture; one of a slave in chains, of which he distributed many hundreds, with a view of exciting the humane to assist in the abolition of the slave-trade; and the other a cameo of Hope, attended by Peace and Art and Labour, which was made of argillaceous earth from Botany Bay, to which place he sent many of them, in order to shew what their materials were capable of, and to encourage the industry of the inhabitants.

To this brief account of some of the numerous productions of Mr. Wedgwood, we shall subjoin the tribute paid to his industry and genius by an elegant modern poet:

"Gnomes! as you now dissect with hammers fine
The granite rock, the noduled flint calcine;
Grind with strong arm, the circling chertz betwixt,
Your pure kaolins and petuntzes mixt;
O'er each red faggar's burning cave preside,
The keen-eyed fire-nymphs blazing by your side;
And pleased on Wedgwood ray your partial smile,
A new Etruria decks Britannia's isle.
To call the pearly drops from Pity's eye;
Or stay Despair's disanimating sigh,
Whether, O Friend of Art! the gem you mould
Rich with new taste, with ancient virtue bold;
Form the poor fetter'd slave on bended knee
From Britain's sons imploring to be free;
Or with fair Hope the brightening scenes improve,
And cheer the dreary wastes of Sydney-cove;
Or bid Mortality rejoice and mourn
O'er the fine forms on Portland's mystic urn.
Whether, O Friend of Art! your gems derive
Fine forms from Greece, and fabled gods revive;
Or bid from modern life the portrait breathe,
And bind round Honour's brow the laurel wreath;
Buoyant shall sail, with Fame's historic page,
Each fair medallion o'er the wrecks of age;
Nor Time shall mar, nor Steel, nor Fire, nor Rust,
Touch the hard polish of the immortal bust."

The demand for Staffordshire ware very much increased, and it became a commercial article of exportation of very considerable value.

The district which Mr. Wedgwood inhabited became by his means the seat of population and abundance. The vicinity was enriched, and a new canal of importance, called the Grand Trunk canal, and connecting the Trent and the Mersey, was obtained and executed by his influence. The ample fortune which he acquired was liberally enjoyed, and benevolently applied to many purposes of private charity and public utility. Chemistry and the arts in their mutual connection were objects of his attention; and he contrived an instrument for measuring high degrees of heat, called a pyrometer, of which he gave an account in the *Phil. Transf.* for 1782, 1784, and 1786. See THERMOMETER.

The disposition and manners of Mr. Wedgwood were no less estimable than the powers of his mind; so that he was as much the object of admiration and esteem for his moral as for his intellectual qualities. So much was he respected, and so desirable was the continuance of his useful life, that he died, universally regretted, at his house in Staffordshire, to which he gave the name of Etruria, in January 1795, in the 65th year of his age. Aikin's Chem. Dict. Gent. Mag. Parkes's Chemical Catechism. Parkes's Essays.

WEDINOON, in *Geography*, a district of Suse in the southern division of Morocco, inhabited by a tribe of Arabs.

This territory is adjacent to the river Akassa, called by some Wed Noon, that is, the river of Noon. Jackson states the population of Wedinooon at 200,000 persons. In this district the sovereignty of the emperor of Morocco is scarcely acknowledged; and the difficulty of passing an army over that branch of the Atlas, which separates Sufe from Haha, secures to the Wedinooones their arrogated independence. Wedinooon is a kind of intermediate depot for merchandize on its way to Soudan, and for the produce of Soudan conveyed to Mogodor. Gums and wax are produced here in abundance; and the people, living in a state of independence, indulge in the luxuries of dress, and use many European commodities. A great quantity of gold dust is bought and sold at Wedinooon. The inhabitants sometimes trade to Mogodor, but prefer selling their merchandize on the spot, as they do not wish to trust their persons with property within the territory of the emperor of Morocco. With Tombuctoo they carry on a constant and advantageous trade, and many of the Arabs are immensely rich. They also supply the Moors of Morocco with (katas) convoys through the desert, in their travels to Tombuctoo. The coast of Wedinooon extends a long way to the southward, nearly as far as Cape Bojador. The river Akassa, commonly called the river of Non or Nun, and in some maps Daradus, is a large stream from the sea to the town of Noon, which is about fifteen miles inland, and about two miles in circumference: from hence the river becomes shallow and narrow; and it is to the southward of this river that ships are generally wrecked. The district of Wedinooon is nominally in the dominions of the emperor of Morocco; but lately an army having been sent farther south than Terodant, and the Pacha Alkaid Mahammed ben Delamy being dead, that district has suffered neglect, and the people pay no tenth, according to the mode of raising taxes in West Barbary, *viz.* ten *per cent.* on the produce of the land, and two *per cent.* on that of cattle; and the emperor has recently ordered his Pacha of Haha to purchase the British slaves that had been wrecked there. This place being only thus nominally in his dominions is another impediment to the redemption of the sailors who happen to be shipwrecked about Wedinooon; for if the emperor had the same authority over this district, that he has over the provinces north of the river Sufe, measures might be adopted by the consul, acting under his orders, for their delivery, without pecuniary disbursements. Jackson's Morocco. See VLED DE NUN.

WEDLOCK. See MARRIAGE, WIFE, HUSBAND, &c.

WEDNESBURY, in *Geography*, an ancient market-town in the south division of the hundred of Offlow, and county of Stafford, England, is situated at a short distance from the source of the river Tame; 19 miles S.S.E. from the county-town, and 125 miles N.W. from London. In the time of the Mercians, this place had a noble castle, which was fortified by Adelfleda, who was for some time governess of this extensive kingdom: but no part of the fortrefs now remains, except a few traces of its foundations. At the Norman Conquest, the manor became a portion of the royal demesnes. Henry II. bestowed it on the family of the Heronvilles, from whom it passed, after various successions, to the Beaumonts. The town is distinguished for its numerous and valuable manufactures, the principal of which are of guns, coach-harnes, iron axle-trees, saws, trowels, edge-tools, bridle-bits, stirrups, nails, hinges, screws, and cast-iron works of every description. For their proficiency in these various branches, the inhabitants are chiefly indebted to the abundance and excellence of the coal obtained in the immediate vicinity. This coal is indisputably the best in the kingdom for the smith's forge, on account of the intense

heat which it produces. It extends in a variety of separate veins or strata, which are particularized by the miners with the greatest accuracy. Here is also found that peculiar species of iron-ore denominated blond-metal, used in the manufacture of horse-shoes, hammers, axes, and heavy tools. Some spots likewise abound with a sort of reddish earth, called hip, employed in painting and glazing vessels of various kinds. A weekly market on Wednesday affords the town a plentiful supply of all kinds of provisions. The population of the parish, in the return of the year 1811, was stated to be 5372, the number of houses 1004. One of the collateral branches of the Birmingham canal, entering this parish, affords the inhabitants great facility of commercial communication. The church is an ancient structure, and some writers absurdly relate, that it was built in the year 711, by Dudo, lord of Dudley. At one end rises a tower, supporting a lofty spire: the interior is divided into a chancel, nave, and two aisles; the latter are separated from the nave by a range of arches, supported by octagonal pillars. In the chancel are several prebendal stalls, ornamented with exquisite carved work. Here is also a variety of monuments in honour of the ancestors of the Dudley and Harcourt families, and several other ancient tombs and memorials. Round the church-yard some vestiges of the castle may be distinctly traced.—Shaw's History of Staffordshire, folio, 1798. Beauties of England and Wales, vol. xiii. Staffordshire, 1811.

WEDNESDAY, the fourth day of the week, formerly consecrated by the inhabitants of the northern nations to Woden or Odin, who, being reputed the author of magic and inventor of all the arts, was thought to answer to the Mercury of the Greeks and Romans, in honour of whom they called the same day *dies Mercurii*.

WEDNESDAY, *Asb.* See ASH-Wednesday.

WEDNOCH, in *Geography*, a river of England, which joins the Wever, near Northwich, in Cheshire.

WEDUM, a town of Sweden, in West Gothland; 18 miles S. of Skara.

WEE-CHAUNG-HOO, an extensive lake of China, which divides the province of Shan-tung from that of Kiang-nan, and supplies an adjoining canal when it is deficient of water. This lake affords a charming prospect, particularly at sun-rise; when its borders fringed with wood-houses and pagodas on the sloping grounds behind, and the surface of the water almost covered with vessels crossing it in different directions, and by all the various modes of navigation that poles, paddles, oars, and sails, are exhibited to advantage. Fishing forms a considerable part of the occupation of the people on this lake, and they have various modes of conducting it. Besides nets, which are in most common use, they have another method, which is more singular: to one side of a boat a flat board, painted white, is fixed at an angle of about forty-five degrees, the edge inclining towards the water on moon-light nights; the boat is so placed that the painted board is turned to the moon, from whence the rays of light striking on the whitened surface give it the appearance of moving water, on which the fish being tempted to leap as on their element, the boatman raising with a string the board, turns the fish into the boat. Water-fowl are also taken upon this lake by a peculiar device. Empty jars or gourds are suffered to float upon the water; that such objects may become familiar to the birds; the fisherman then wades into the lake with one of the empty vessels on his head, and walks gently towards a bird, and lifting up his arm draws it down below the surface of the water, without disturbing or alarming the rest, and thus presently fills the bag with which he was provided for securing

ing his prey. A similar practice exists, as we learn from Alloo, among the nations of Carthage, upon the lake Ciengo de Terias. Staunton's Embassy, vol. ii.

WEED, in *Agriculture and Gardening*, any sort of uncultivated and unprofitable plant or vegetable which grows in ground, and which, in consequence of the mischief it does, requires to be extirpated and destroyed.

Weeds may be distinguished, according to the different periods of their duration, into the *annual*, *biennial*, and *perennial* kinds.

The first division comprehends all such as die after perfecting their seeds in the first year. Weeds of this class, though abundantly productive in seeds, and consequently in plants, are capable of being destroyed without any great difficulty.

The second division includes all such weeds as endure a greater length of time than one year, and which after perfecting their seeds in the second year perish. These, like the former, are in general abundant in the production of seeds as well as plants, but they are destroyed with greater difficulty.

The third division comprises all those weeds which are capable of continuing many years. Some of which have the property of perfecting their seeds annually, without being thereby destroyed; while others, less prolific in seeds, have the faculty of reproduction in their vivaceous roots; and there are others that are capable of increase both by seeds and roots. The plants of this class are therefore much more troublesome and difficult of destruction than the others.

In the nature and vegetation of the seeds of weeds of different sorts, there is considerable diversity. Some are found to sprout forth as soon as they have a sufficient degree of moisture, sending down their roots though not in exact contact with the earth; others only begin to germinate when they are deposited and inclosed in a suitable soil, and have the proper influence of the atmosphere; and there are many of these kinds of seeds, even of the very small sort, which are capable of remaining in a dormant or inactive state for a very considerable length of time, and afterwards vegetate on being placed in a favourable situation, in regard to the influence of the air, and other matters.

There are other seeds of weeds, too, which are provided with a soft feathery material which performs, in some measure, the office of wings, by which they are conveyed from their native situations, and disseminated over lands and places at a considerable distance.

There is likewise a difference of some consequence in the vivaceous roots of vegetable weeds; some being branched, others entire; some descending directly downwards, others inclining; some fibrous, others tuberous; some creeping, others knotted or jointed, &c.

The great variety and multiplicity of weeds render it a difficult matter to arrange them in any useful manner for the purposes of the farmer, as different sorts of them are found to prevail in different situations and kinds of land. A late intelligent writer has, however, considered them as affecting gardens; corn-fields and tillage-lands; meadows and pastures; waste and uncultivated grounds; the hedges of inclosures; and woods and plantations.

Weeds injurious to garden grounds are chiefly these:

Couch-grass, or which in some places is known by the names of twitch, squitch, and many others, and which not unfrequently comprehends the creeping roots of the hardy perennial grasses, which are particularly tenacious of growth, as dog's-grass, white bent-grass, tall oat-grass, and some others. Of which, the two first are readily distinguished

by their flowering stalks, as well as by the ears which contain the seeds; and the last has been observed to have a bulbous-jointed root, that affords shelter to various destructive grubs, worms, and insects: they should all be carefully rooted out and destroyed. These are to be destroyed in gardens by carefully picking out the roots in digging, and as carefully rooting up whatever remaining fragments of the roots may send out a shoot above the ground. These should never be allowed to get to any height, but be exterminated as soon as possible. See *TRITICUM Repens*, *AGROSTIS Alba*, *AVENA Elatior*, &c.

Suffolk-grass, or dwarf meadow-grass, is another grass, which, though useful in pastures, is a very pernicious weed in gardens and places about houses. It is common in places where the surface is not liable to be often disturbed by means of cultivation. Its prolific quality, in respect to seeds, is so great, that it is said to be capable of producing and reproducing itself four times in the course of one summer. It may be destroyed by rooting it out before its seeds are perfected and shed about, otherwise the vegetation of them will be so abundant and extensive as almost to bid defiance to the powers of the weeder. See *POA Annuua*, &c.

Catchweed, or what in different situations is called goose-grass, cleavers, hariff, &c. is sometimes a troublesome garden weed, but it is more common in the hedges. This is a weed that may be readily destroyed in garden-grounds, by pulling it up before the seeds are perfected.

It is said that young geese are very fond of the tender branches of this weed; and that the seeds of it are capable of being used instead of coffee. See *GALIUM Aparine*.

Garden nightshade is said to be a common weed in the garden-grounds about Chelsea and Brompton, but which is seldom found in those in the country, though sometimes met with on dung-hills, and other such places. See *SOLANUM Nigrum*.

Goosefoot, which is a weed of the wild orache description, is common and luxuriant in many garden-grounds, being very prolific in seeds, and in the produce of weeds therefrom, if not rooted out before the seeds are scattered about on land under cultivation. These, like all other annual seedling weeds, is to be destroyed only by rooting up before the seeds of it are scattered. See *CHENOPODIUM Album*, *Viride*, and *Hybridum*.

Wild orache, or fat-hen, is a weed nearly allied to the above, and from which it is distinguished only by some of the flowers having pointals only, while others on the same weed-plant have both chives and pointals, in common with the above sort of weeds. The flowers are small, so that this distinction can only be ascertained by the microscope. It is a weed which grows much in kitchen-gardens, on rubbish, and on dung-hills; is an hardy annual, very fertile in seeds; and which is to be prevented or destroyed in the same way as the above kinds. See *ATRIplex Hastata*.

Fools' parsley, or lesser hemlock, is a weed common in gardens, and which, in its early growth, has much resemblance to parsley, for which it is often mistaken, and when eaten occasions sickness, swelling, and uneasiness about the stomach: it should always be rooted out of garden-ground, when it is running to seed, as at that time it is easily known and best destroyed. See *ÆTHUSA Cynapium*.

Knot-grass is a weed that sometimes grows much on the gravel-walks of gardens and pleasure-grounds, trailing to a considerable length in all directions, being very prolific in seeds, which readily take root. It is, therefore, necessary to root it well up before they become ripe: hogs
are

are said to be very fond of eating it. See *POLYGONUM Aviculare*.

Ground-ash is said to be a very troublesome weed in the garden-grounds in the neighbourhood of London; but which some suppose to be mostly confined to the shade of hedges. It is believed to be perennial in its nature. In order to get rid of it, the best mode is to cut it up on its first appearance. See *ÆGOPIDIUM Podragaria*.

Chickweed is a weed that sometimes grows with great rapidity, and in a very luxuriant manner on garden-ground that is much pulverised and reduced by operose cultivation by the spade, and which is much enriched by good manure: it is an annual weed, very productive of seeds, and where it abounds much, it is perhaps improper to give the land or ground a fine culture until it in some measure disappears: swine are extremely fond of this weed, and it is said to be a grateful food for young chickens. See *ALSINE Media*.

Black-bind-weed in some places is called bear-bind. It is a parasitical weed-plant, often climbing up bean and other garden crops: it is hardy, and extremely prolific in seeds. To keep garden-ground clear of it, the seeds should never be suffered to shed or sow themselves: the seeds contain a white flower, and are said to be good for pigeons, poultry, and small birds of different kinds. See *POLYGONUM Convolvulus*.

Sun spurge is an annual weed, said to be not very troublesome or difficult of eradication, yet not uncommon in garden-grounds. See *EUPHORBIA Helioscopia*, &c.

Red dead nettle, or dee nettle, is a weed of the annual kind, according to some, but which others consider as a perennial. It is common in garden-grounds, flowering early, and for the greater part of the year. The seeds should not be suffered to shed or disperse themselves over the ground, but the weeds be cut up as soon as they appear. See *LAMIUM Purpureum*.

Henbit is an annual garden-weed, that should likewise be weeded out before the seeds of it are perfected and scattered. See *LAMIUM Amplexicaule*.

Nettle hemp is a weed of the luxuriant, disagreeable, garden kind, that should always be rooted out of the ground, and kept under in time to prevent its future mischief. See *GALEOPSIS Tetrabit*.

Garden sow-thistle is a common weed of luxuriant growth, doing great injury to the cultivated crops. It is directed that the seeds of this weed should never be suffered to shed and spread themselves in any situation; for, being furnished with feathers, they fly over a country with the wind, disseminating themselves widely, and vegetate on the first loose or cultivated ground on which they settle. It is a favourite food with rabbits and hogs. See *SONCHUS Oleraceus*, and *THISTLE*.

Fumitory is a common, though not very injurious or hurtful weed. It is an annual, and may, consequently, be destroyed by preventing its seeding in an effectual manner. See *FUMARIA Officialis*.

Common thistle is a disagreeable and troublesome weed; the seeds of which are numerous, and provided with a downy material to carry them any distance before the wind. They should be drawn up by the roots in moist weather with forceps or tongs for the purpose, as they cannot be pulled by the naked hand.

Garden-grounds are always to be kept well freed from weeds of this sort by all proper means. See *SERRATULA Arvensis*, and *THISTLE*.

Groundsel, which is another very common and troublesome weed in garden-grounds, and the seeds of which are

feathered, as in the former case, being capable of sowing and spreading themselves far and near, with this farther chance of propagating themselves, that the plant or weed is extremely quick of growth. The eradication of this weed from gardens must consequently require unremitting attention, by cutting up the young plants as soon as ever they can be discovered, and letting them run to seed as little as possible. See *SENECIO Vulgaris*.

Common nettle is a weed that generally grows in hedges or other shady places, but which sometimes appears in other places and in garden-grounds; in which cases, it must be destroyed by rooting it up in a complete manner. The leaves of this weed, when cut small, may, it is said by some, be mixed with the food of turkeys, and other poultry, with benefit. See *URTICA Dioica*.

Mistletoe may be ranked as a garden-weed, and is very common on fruit-trees, and it is said to be very hurtful in preventing their bearing; it should, of course, be pulled off in time, so as to prevent that sort of injury. It is sometimes, too, plucked off as a sheep-food in the winter, in hard stormy seasons. See *VISCUM Album*.

Cultivated early potatoe, though it cannot be properly ranked as a weed, is often troublesome in gardens. It is said, that however valuable as a crop, it is very apt to remain in the ground, and intrude itself among other after-crops, to their injury, as well as giving a slovenly appearance to the culture. As, however, it is now found that the shoots of this root will crop well after being transplanted, it would seem to be the best way to have them taken up from among other crops as they appear, taking the advantage of showery weather, and putting them into a bed by themselves, where they may succeed some early crop, such as winter greens, spinach, forward cabbage, and such like, by which means other crops may be rendered clean, and these roots be provided without any expence of seed or sets. See *SOLANUM Tuberosum*, and *TRANSPLANTING*.

Weeds injurious in Tillage and Corn Lands.—The principal of those weeds which decidedly infest and injure grounds under the plough are those given below.

Ivy-leaved chickweed is a weed that is said sometimes to abound very much amongst wheat very early in the spring, but that as seeding and leaving the ground early, may perhaps not much injure the crop: the seed is asserted to ripen in twenty-eight days from the first vegetation of it and the springing up of the plant, which mostly appears in the month of March, and often sends forth a plentiful produce of seeds, which will lie in the ground many years, ready to vegetate the next time the land is broken down and pulverized early in the spring: this sort of work should, therefore, in this case, be done in the fallow, where that practice is in use, which would occasion the seeds to vegetate; but in other cases it may be destroyed by being ploughed under before the seeds of it begin to ripen. See *VERONICA Hederaifolia*.

Lamb's lettuce, or corn-fallad, is a weed that has lately been observed to be more frequent in some districts than formerly. It has been found in a hard tilled field in great abundance. It is an annual weed; and, though not very formidable, ought to be removed from tillage-lands, as it takes away a portion of the nourishment belonging to the cultivated crops. This may pretty readily be done by pulling or cutting it up, or turning it under by the plough, where it can be used, before the seeds of it be perfectly formed. See *VALERIANA Locusta*.

Couch of tillage-land is the produce of the three grasses already noticed in a similar title, under the head of garden-weeds, with the addition of the roots of the creeping soft grass,

grafs, and probably some others. It is said to be the plague of arable cultivation; and that the roots of these weeds are sometimes so interwoven together in the land or soil in ground that has been under hard tillage and bad management, as to form a perfect matting, and to choak the plough: they abound most, it is observed, in light and mixed soils, not infesting strong clays in an equal manner. The arable land squitch-grafs, which is the most general, is, it is said, of the *agrostis* family; but to which particular species or sort that the most complained of by farmers belongs, is not yet well agreed upon. Some refer it to the fine bent, while others assert it to be a variety of the white. And there are others of great authority who think this squitch-grafs has never yet been rightly specified or referred. The ear or awn of this grafs has, however, been often observed to have the general habit of the *agrostis*; and that it is very probable that more species than one of this genus have the property of running in the roots, and producing couch.

It is noticed, in addition, that the creeping red-stalked bent grafs, and the creeping soft grafs, are common squitch or couch-grasses on strong or cold wet tillage-lands; and that the tall oat-grafs is a very usual squitch-grafs, on the light gravelly soils of some neighbourhoods; that its roots are composed of a bunch of bulbs, which afford shelter to pernicious vermin, as already seen; and that it is difficult of eradication, and very pernicious to crops, especially in wet seasons.

The *dog-grafs couch*, which, in the county of Salop, is often termed *scutch*, is very common every where, and well-known to the cost of the farmers.

Withering, after observing that it can only be destroyed by fallowing in a dry summer, states, that at Naples the roots are collected in quantity, and disposed of in the market to feed horses. The taste is much similar to that of liquorice, dried and ground into meal, which has been made into bread in years of scarcity. They have besides a detergent quality, and may be useful in the diseased livers of animals.

However, these grasses, though so troublesome and injurious as weeds on arable lands, are yet probably good as affording meadow-herbage, where their roots are not so liable to run or spread themselves as on tillage-land that is loosened, broken, and reduced, by being constantly wrought by the plough, and other tools.

The destruction of weeds of this sort on arable land, is chiefly effected by the free use of the plough, and other suitable implements, when the weather is in a proper state of heat for the purpose: some think the business can only be effected by giving an early and complete spring and summer fallow, by repeated ploughings in time of hot weather, with sufficient harrowings between each ploughing, to work out the squitch, and bring it to the top; and that unless the summer prove dry for some length of time, even this will be insufficient; in which case, many active and industrious farmers have it forked together by hand and burnt: others have it collected and carried into heaps to rot; and it is sometimes mixed with quick-lime, and reduced into a sort of compost heap, which is a practice to be much commended, as wholly destroying it, and at the same time converting it to use: it should not, however, be forgot, that the great increase of the roots of these weeds is occasioned by hard tillage, or bad management, and often by both. In the county of Gloucester, it is said by the writer of the corrected account of the agriculture of that district, to be a most troublesome and almost unconquerable weed on clay-lands, but that on light lands and loams it

may be dragged out and finished by hand-picking with tolerable ease; while on the stiff soils, and particularly in the wet furrows, nothing but repeated ploughings and exposure to the heat of the sun during the summer can check the increase of it; hence, in that county, the vale-lands, after a wet summer, are generally foul. A crop of spring-vetches is said to be well suited to smother and keep it down, and other smothering green crops may be had recourse to in the same intention. See *TRITICUM Repens*, &c. Also *AGROSTIS Stolonifera*, *HOLCUS Mollis*, &c.

Wild oat, or *laver*, is a common weed on hard tilled land, and when abundant, very unsightly and injurious to a crop. It has been observed by Dr. Anderson, it is said, that this weed-plant abounds so much in the corn-fields in most parts of Aberdeenshire, as in many cases to constitute nearly one-half of the bear or six-rowed barley-crop, which is much grown in that part of the kingdom: it may be destroyed or greatly reduced by the turnip-culture, or by well-managed early fallowing; and prevented by short tillages, and frequent seeding down to grafs. Dr. Withering, and the *Flora Rustica*, have stated, that the awns of it are used for hygrometers, and the seeds instead of artificial flies in fishing for trout. The author of the Corrected Report of the Agriculture of the County of Gloucester states, that it is the growth of particular districts, and that it cannot be destroyed; that in fields where the greatest care has been taken to hand-pull every stalk, it has appeared in the following year in equal abundance. That in new broken up leys, which have been in turf or sward beyond the memory of man, these weeds often spring up with as much luxuriance as if they were the natural produce of the soil. When the land is planted with beans or peas, hoeing will check and reduce them; but when they grow among wheat, it is not easy to distinguish the plants while young; and that in this case, they are left until they are nearly in ear, and are then drawn out by the hand. See *AVENA Fatua*.

White darnel is a weed not unfrequently found in wheat-crops, though, it is believed, almost always produced from the seed of it sown with that grain, to prevent which, consequently, great attention should be paid to clean seed-wheat, and particularly that it contain none of the seeds of this weed, as it is extremely prolific, very injurious to a crop while growing, and to the value of the produce at market. It is an annual weed, which has never been recollected to have been seen growing, except in a crop, and but rarely there without neglect in the management of the seed grain, and in other ways. See *LOLIUM Temulentum*.

Goose-grafs, or *catchweed*, &c. is a weed in tillage-land, the seeds of which are roundish, rough, two from each flower, so large as not all to be easily separated from the grain in dressing. This weed is not very common in well-managed lands and crops, being more generally restricted to the hedge banks. It is observed, in the Gloucester Corrected Agricultural Survey, to be a troublesome and frequent weed, on all sorts of soils among corn, and which is not easily destroyed, except by much early care and attention. See *GALIUM Aparine*, and *Spurium*.

Field scabius is a weed found sometimes in corn-fields, as well as pastures, though not very abundant. See *SCABIOSA Arvensis*.

Parsley-piert is a diminutive weed of but small account, though sometimes too much abounding in tillage-lands. This weed might probably be weakened and lessened when in too great quantity by pulverising and reducing the soil well when in fallow, very early in the spring season, and by
ploughing

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ploughing it under in due time, so as to prevent its seeding. See *APIANES Arvensis*.

Dodder is a parasitical weed, that is said not to be uncommon, in some districts, in the corn-lands. This weed has been observed twining round the stems or stalks of a bean crop in the county of Buckingham, climbing in a spiral direction round them, from which, by means of vessels for the purpose, it draws its nourishment and support, and must, consequently, very much fret and injure any plant to which it may attach itself: it is called in different places, as stated by writers on husbandry, beggar's-weed, hell-weed, and devil's guts, names which sufficiently shew in what sort of estimation it is held by farmers. It is an annual weed, and produced from seed, which takes no root in the earth, but in some part of its foster-plant. It is remarked, by the author of the Corrected Report on Agriculture for the County of Gloucester, to be a great enemy to beans, vetches, and some other such plants, but is never there seen among wheat, barley, or oat-crops. That as soon as it has fixed itself upon the plant, it separates from the root, and, like other parasitical weeds, draws all its nourishment from the plant it has so fixed upon and embraced. Large quantities of beans are, it is said, often ruined completely by it, so as not to carry a single pod; and that no method has yet been discovered to destroy it; for though the root cannot be found, yet it surely returns, it is thought, in some part of the field where it has once begun to grow, whenever the plants on which it feeds, form the crop of the season. Sheep, in some cases, have been found useful in lessening it, by feeding upon it and breaking its runners, when they can be turned into the land where it prevails. See *CUSCUTA Europea*.

Corn bind-weed is another troublesome parasitical weed in arable-land, often growing amongst wheat, and, when abundant, twining round the stalks of the corn, and very much injuring the crop, when the wheat has been laid by heavy rain. It is said not to be so common in some of the midland counties, as in some of those nearer the metropolis, whence they are in the habit of procuring and being supplied with seed-wheat; on which account it has sometimes been feared that it might be introduced more abundantly by such means: but as the seeds are small, they may easily be dressed out in case of such accidents. It is a perennial weed, and much addicted to running in the root. It has been proved by an experienced writer, that cutting it off, even below the surface of the ground, only tends to spread it farther: it must be reduced and destroyed, if possible, by means of fallowing, and using the same process as for couch or squitch. In some districts this weed is most frequently found in clays and deep loams, in which the roots strike so low, that even trenching two spits and an half deep will not, it is said, reach their extremities; and that the smallest bit of a root left in the ground will spring and rise to the surface. It entwines round and entangles all plants in such a manner, as either to bring them to the ground, or check their vegetation, by injuring their structure on the surface of it. See *CONVOLVULUS Arvensis*.

Wild carrot is a common and sometimes a troublesome weed, in dry tillage-land. It is a biennial weed-plant, producing seed in a plentiful manner. Though some, as Withering, assert that this, in its cultivated state, is the common well-known garden carrot; yet others, as Miller, contend that the wild carrot could never be improved so as to render the roots in any degree comparable with the cultivated carrot. However this may be, where it is found in quantity, it should be prevented from seeding, in order to reduce it, and bring it properly under, which may be ef-

fectured by cutting or pulling it up in its early growth. See *DAUCUS Carota*.

Shepherd's needle, or beggar's needle, is a weed sometimes abounding in hard tilled land, and the seeds of which are not wholly separable with ease from grain in dressing. It is a small annual weed, that produces a plentiful crop of seeds, each seed being furnished with a spike or beak of from one to two inches long, whence its name of needle. It seldom abounds much in well cultivated and managed land. See *SCANDIX Pecten*.

Chickweed is, in some cases, a troublesome weed in a crop on land which has been rendered fine by tillage, and from which it should, therefore, be rooted out. It has been remarked by the Rev. Mr. Shaw, it is said, that this weed is an excellent out-of-door barometer:—that when the flower expands boldly and fully, no rain will happen for four hours or upwards; that if it continue in that open state, no rain will disturb the summer's day; that when it half conceals its miniature flower, the day is generally showery; but that when it entirely shuts up, or veils the white flower with its green mantle, let the traveller put on his great coat, and the ploughman with his beasts of draught rest and retire from their labour. In Gloucestershire it is stated that it grows most plentifully on the good and well cultivated lands. It there mats so closely round the plants, and covers the surface so completely, as to keep out the influence of the sun and air; and consequently requires to be removed, which is most best performed by the hoe. It may be thus kept under, if not wholly removed and destroyed. See *ALSINE Media*.

Curled dock is a mischievous weed in tillage-land, and should never be suffered on any account to seed its seeds, and spread them on any land, but be rooted up and carried off in time, to prevent injury. In arable ground, the roots are best picked off with care during the time the land is in tillage, as they will otherwise produce vigorous luxuriant plants which will draw much nourishment from the soil, to the great injury of the ground, and of the intended crop. It is a hardy perennial weed, which is very tenacious of growth by its roots, and producing a wonderful increase of seeds: too much caution cannot, therefore, be used to avoid sowing it, nor too much pains be bestowed in its extirpation and destruction. Withering asserts it to be the pest of clover-fields in Norfolk. See *RUMEX Crispus*.

Arsenaris, or lake weeds, are plants of this kind, sometimes met with on the wetter sorts of arable lands. They abound most in wet seasons, on the heavier and more moist sorts of ground; and as being hardy annuals, producing a plentiful supply of seeds, are apt to shew themselves in the crops of grain. They are weeds which are to be destroyed by proper fallowing, by the removing of the wetness of the land, and by the rooting out of the plants in proper time to prevent their seeding. See *POLYGONUM Persicaria*, and *Pensylvanicum*.

Knot grass is sometimes a tillage-weed; trailing in its habit of growth; flourishing most by the way-sides: when out of the smothering crops, it is very prolific in seeds. It should be got under by preventing its seeding, by rooting it out sufficiently early for the purpose. See *POLYGONUM Aviculare*.

Bearbind, or black bindweed, is a parasitical weed that twines round any thing it can lay hold of, and which is sometimes found among field crops, to their great injury. It is very productive of seeds, which, being angular, are not easily separated from grain in dressing or winnowing it. It is nearly allied, it is said, to buck-wheat, and to which it is preferred by Dr. Withering, who asserts that the seeds are

are quite as good for use as those of that wheat, are produced in greater quantity, and the plant bears cold better. From its twining hurtful nature, when among crops, it should be early destroyed, and prevented from feeding and multiplying itself. See *POLYGONUM Convolvulus*, and *Sagopyrum*.

Knawell is a diminutive weed, but prolific in seeds, and of vigorous growth; it is often found on pieces of poor thin soil, when in tillage, but is not believed to be very pernicious: it may probably, when necessary, be weakened, reduced, or destroyed, by an early spring working of the land when in fallow. See *SCLERANTHUS Annuus*, and *Perennis*.

Bladder campion is a weed that is common in wheat and barley crops, growing in tufts, with many stalks from each root; which, when the case, should be rooted out by the hand, or other convenient method. It is a perennial weed, and has the habit and property of increasing from the roots. See *CUCUBALUS Behen*.

Cockle is a luxuriant, vigorous, annual weed; perfecting many seeds, and drawing much from the soil or land: care should, therefore, be taken not to sow the seed of this injurious weed. The seeds are so large, that they cannot all be dressed out from the grain, it is said: the plant should, therefore, be plucked out by hand, before the seeds ripen and shed themselves. It is a common weed among wheat and other crops, in many districts. See *AGROSTEMMA Githago*.

Red and white campion are weeds of the perennial kind, growing occasionally in hedges, corn-fields, and pastures. When they become abundant and injurious, they may be weakened, reduced, or destroyed, by well-managed fallows, in most cases. See *LYCHNIS Dioica*.

Moufe-ear is a weed that has somewhat the habit of chickweed, but is of a duller appearance: it is frequent amongst corn-crops, and in pastures, but perhaps not very injurious to the former. See *CERASTIUM Arvense*.

Corn spurry, or yarr, is a frequent weed in corn-fields, though not very bulky or luxuriant, yet quick and tenacious of growth, and producing seeds in a plentiful manner. Dr. Anderson has stated, that in Aberdeenshire it is a pernicious weed, growing in such abundance among the crops as to choke the grain: it has often been seen so thick, that over a vast extent of surface a pin could not have been put down, without touching a plant of it; and that the farmers there think it indestructible: and it is added, that whenever any of the land had been poached, by being used as a road, especially in wet weather, none of this weed appeared there: that it was evident that this was occasioned by the clods, thus produced, not giving room for the small seeds to germinate freely; which suggested, that if, therefore, he could contrive to bring the ground into a cloddy state, when sown, he should be free of the weed for that crop. As a crop of bear or six-rowed barley in one field was entirely lost, the soil or mould being in a loose, mealy, incoherent state when sown; it was resolved to delay ploughing it the next season as long as possible, and to plough it at last when it was very wet. Fortunately it came a violent rain in the beginning of the month of March, and it was ploughed when nearly in the state of a puddle, turning over more like mud than soil or earth: dry weather succeeding, this mud bound, it is said, a little on the surface, and produced a kind of clod; the corn was then sown; it got a very slight harrowing, barely to cover the seeds, in an imperfect manner, and to leave the field as rough as possible: none of the weed appeared, and the crop at harvest was one of the most luxuriant that had ever been seen by the writer. The suc-

cess of this case is not, however, sufficient to recommend it as a general practice.

It has been suggested, that as small birds are very fond of the seeds of this weed, it is probable that, by the surface of the ground being left undisturbed through the winter, a large portion of the seeds would be picked up and devoured by them. It is believed too, that in all cases of a stubble very full of small seeds, it is well to defer the ploughing as long as it conveniently can, on this account. In respect to land rendered very fine by tillage, it is well understood, it is said, by the farmers of some districts, as those of Staffordshire, to be a fault, and that it is much better left only knappy, as they call it, that is, in small lumps. This is attained in fallows, by working the land early in summer, and letting it lie to consolidate through the latter part of it; and in the turnip culture, by the treading of sheep and cattle: and it is one great reason, it is supposed, why land should not have too many ploughings, but only a proper number judiciously timed; however, that ploughing in general, particularly of broken land, is much best done when the land is dry.

By some means of this kind, this small weed may be kept under without much difficulty. See *SPERGULA Arvensis*.

Base rocket is a weed of the annual kind, that does not abound very much, though it is met with in some places. It has been observed among corn in the county of Gloucester. See *RESEDA Lutea*.

Dwarf spurge is a weed that is common in corn-fields, and generally in single plants, but is not very injurious to the crops. See *EUPHORBIA Exigua*.

Corn-poppy is an annual weed that produces numerous seeds, and is sometimes very abundant in corn-fields, being a pretty sure indication of a light crop. It has been questioned, whether the lightness of the crop be occasioned by the abundance of this weed, or the increase of this weed encouraged by the lightness of the crop; and suggested, that probably both are the case. In a full crop it is scarcely to be found; its flowers appear in July. In the Corrected Report on Agriculture for the County of Gloucester, it is stated to be common in all light and sandy soils, particularly in the neighbourhood of that town. But that since the practice of hoeing has become more general, this weed has been much diminished in quantity. It abounds much, too, on chalky stone-brash poor soils, in some cases. And in some parts of Berkshire, it is said, in the account of its agriculture, that the poppy almost conceals the corn, when it is in blossom. It is supposed that it might without doubt be weakened, reduced, or wholly destroyed, in fallows, by promoting an early vegetation in common with other feeding plants. See *PAPAVER Rheus*.

Corn crowfoot is a weed that is sometimes very abundant, and injurious to a wheat-crop, on strong moist land. It is an annual weed of early growth, which can only be brought into a full state of vegetation in the fallow by an early tillage; otherwise the growth of the seeds is, it is said, deferred to the next spring, to the great injury of the crop. In the Flora Rustica it is noticed, that in some countries it has the name of hunger-weed, whence it is supposed to indicate a barren soil. The orthography, however, is not, it is said, derived from the nature of the soil, but from the hungry prospect it holds out to the farmer. In the county of Gloucester, it is said to grow most abundantly in strong loamy or clayey soils; and that deep and frequent stirrings with the hoe are to be had recourse to, as the most proper means for reducing it, and keeping it under. See *RANUNCULUS Arvensis*.

Dec nettle, or dead nettle, is a weed that much abounds among

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among tillage-crops, on some lands, especially in moist seasons. As the weeds are perennial, and produced both from seeds and the roots, great pains are necessary to be used in their extirpation and destruction. There are sometimes different sorts met with among crops. See *LAMUM Album*, and *Purpureum*.

Calves' snout is a weed in tillage-lands, in different districts. It has been observed not to be uncommon among the corn-crops in Hampshire, in some summers. It would appear too from Withering, that several other species of this genus are common in corn-fields, which are annuals; but the nature of them, or how far they are injurious to cultivated corn-crops, has not yet been determined. See *ANTIRRHINUM Orontium*, *Elatine*, *Spurium*, *Arvense*, and *Minus*.

Shepherd's purse, or pouch, which, with some others, are well-known weeds, are sometimes troublesome on arable land. They are annuals of early appearance, and continue a great part of the year. They are to be reduced and destroyed by early and well-directed fallowing, or by being rooted up from the ground at an early period. See *THLASPI Arvense*, *Campetere*, and *Bursa Pastoris*.

Whitlow grass is said to be a weed among corn, in some cases and sorts of land, early in the spring; but how far injurious is not well ascertained: it should, however, when in quantity, be kept well under. It is but small, though quick in growth, and exhausted in a short time. See *DRABA Verna*.

Coddled mouse-ear is another diminutive weed, that shews itself early sometimes among corn in tillage-lands; but being rapid in its vegetation and decline, is not of much importance as a weed to farmers.

Smooth and rough-leaved and pale-flowered chadlocks, &c. are weeds that are extremely troublesome and distressing to farmers on tillage-lands, in some places. The writer of the paper on weeds alluded to above has stated, that these three plants are sometimes confounded together by farmers, under the general name of chadlock, pronounced in the district where he lives kedlock, and in some others ketlock, though they are as distinct to the investigating inquirer as wheat, barley, and oats. That they are all extremely common, or nearly equally so, if a large range of country be examined; though the different sorts are more or less abounding in different places; that in his neighbourhood he can generally gather the three kinds in the same field, but the mullard is much the most abundant. In the vicinity of Litchfield, where chadlock is indeed very abundant, it is almost universally wild rape. Some years ago, the writer observed, in the common fields of the county of Rutland, that the whole surface was tinged over with the flowers of the wild radish. They are all great nuisances, and, when suffered in abundance to ripen their seeds, must of necessity draw much from the soil, to the great injury of the crop among which they are; and that as they are very quick of growth, and perfect their seeds expeditiously, it is not uncommon for these weeds to shed their seeds at the rate of several bushels on the acre; and as it is well known that the seeds are capable of vegetating, after lying many years in the ground, it is no wonder they should produce a plentiful crop; yet, being simply annuals, they are not difficult of destruction, if due attention and proper means be used. In order to destroy these, as well as all other seedling weeds, the land in tillage should, it is thought, be pulverised and reduced early in the spring by ploughing and harrowing, after which warm weather and rain will soon cause all the seeds that are near the surface to vegetate; they may then be permitted to grow until they begin to flower, when they

are to be ploughed in, and the land again harrowed; and the next rain will then cause most of the remaining seeds to shoot, which are in due time to be ploughed under as before; and if any should afterwards appear amongst the crop, they should be hoed or hand-weeded out: by this means, in one or two tillages, these weeds may be totally eradicated; but if they be permitted to shed their seeds, their increase cannot be wondered at, when their prolific nature is considered, as well as the extreme hardness of their seeds. The seeds, when dressed from grain, have, it is understood, been frequently manufactured into oil.

The weed called charlock, in many places, is said to be the most common of any in the vale of the county of Gloucester. It is most probably the same with the wild mustard, just noticed. It is said, that during the summer, both on the fallows and in the planted fields, its yellow blossoms predominate over every other plant, and that unless destroyed in this state, leave an immense crop of seeds behind. In order to check the increase of this weed, the attentive farmer suffers it to come into blossom on the fallows, and then turns it in with the plough. This is not always, however, effectual; as frequently the plants being merely moved, but not from the roots, and two or three inches of the tops left above ground, soon recover the injury they have sustained, and go on to seed before the next ploughing. Women and children should, therefore, go over the ground with the hoe a few days after the ploughing, and cut up the reviving plants; or lambs should be kept on such fallows, which are said to eat off the tops with avidity. In the planted fields they are hoed and weeded, but as some will unavoidably escape, women are put in among the corn, after it is grown to a considerable height, to pull out the weeds in blossom with the hand. Though the farmer will certainly diminish the quantity, and prevent any new accession by this attention, yet many years of good husbandry must elapse, before the ill effects arising from the negligence of former cultivators can be conquered; for the seeds being strongly charged with essential oil, will continue in the ground for an incalculable length of time uninjured; and as often as the soil is turned up, a quantity of them will be brought sufficiently within the influence of the atmosphere to vegetate. In 1804, in the parish of Brockthorpe, in the above county, a considerable portion of the land in the common field was seen completely covered with this weed, and the seeds perfectly ripe and scattering on the ground. The ploughing had been neglected until nearly the autumn, and as the land was not cropped, the charlock grew in great abundance, and left more seeds than the good husbandry of half a century will be able to eradicate.

It has been stated, that what is vulgarly called charlock in the vale of the above district, is in reality the common wild mustard grown in the north for its flour. That it is there often collected by the country-people for the same purpose; and before the simple mode of living among the ancient farmers fell into disuse, few farm-houses were without a cannon-ball and bowl, in which the mustard-seeds were bruised, and the flour saved for the table with the black hulks unseparated from it.

The name charlock is not unusually applied by farmers to different plants of the weed kind, that are equally noxious and hurtful in arable lands, and some of them perhaps more frequent in such situations than some of the above, such as wild mustard and rape, &c. See *BRASSICA Napus*, *SINAPIS Arvensis et Nigra*, *RAPHANUS Raphanistrum*, &c.

Wild rocket is a weed found in tillage-lands in some districts. It is said, that this weed has made great progress in the corn-fields in some places, and is considered as a very formidable

formidable and hurtful plant of that kind. All the parts of this are considerably acrid, and have a rank disagreeable smell; whence it is called by those farmers who have it in their lands *stinkweed*. It may, it is supposed, doubtless, be reduced and destroyed by the processes already recommended for the destruction of chadlock. See *BRASSICA Muralis*.

Fumitory is an annual weed, that is not uncommon or unusual in corn-fields, though not very greatly pernicious in them. It should, however, be kept well under where it is in any quantity. See *FUMARIA Officinalis*.

Rest harrows are weeds sometimes met with in tillage-lands. They are chiefly two sorts, the former of which is said not to be uncommon in arable lands, where there are no very desirable plants. It is common in some districts among corn-crops, and an hardy perennial weed. In its destruction, if the root can be got rid of in the fallow, there is little danger, it is said, from the seeds: the roots are sometimes so strong as almost to stop the plough, unless the team be pretty strong. The latter is frequently met with in some places, but is unknown in some of the midland counties. See *ONONIS Arvensis*, or *Spinosa*.

Tare, particularly in the wild state, is a weed very injurious to corn-crops. It is said to be a terrible enemy to a wheat-crop, where it abounds in considerable quantity. Withering says, that in wet seasons whole fields of corn have been overpowered and wholly destroyed by it. Care should be taken, that seed-wheat be perfectly free from the seeds of tares; and all land subject to them should be got, if possible, so forward in the fallow, as to bring on the vegetation of this weed previously to the sowing of the wheat: the seeds of this weed are said to be good food for pigeons, poultry, and many other sorts of birds. See *ERVUM Tetraspermum*, and *Hirsutum*.

Rape, in some cases, is a very injurious weed in arable land. It should, in all cases where it prevails much, be prevented from ripening and shedding its seeds, as when this is not the case, the farmer has long to regret the consequence of his neglect. See *Chadlock supra*.

Melilot is a weed very troublesome in tillage-land. The writer of the paper already noticed says, that it is a very injurious corn-weed in many parts of the kingdom. That Miller marks Cambridgeshire, and Gerard, Essex, as abounding in it. That it has been heard of in Bedfordshire, and seen among corn in Gloucestershire and Rutlandshire: that in the latter county, five or six shillings the acre have sometimes been said to be expended in weeding it out, without fully effecting the purpose. According to the *Flora Rustica*, there cannot be a worse weed among bread corn, for a few of the seeds ground with it spoil the flour, by communicating their peculiarly strong taste to it. That it flowers in June and the following month, and the seeds ripen with the corn; and that it is probably capable of propagating itself, both by its roots and seeds, but might doubtless be much weakened and reduced by proper fallowing: that horses are very fond of it; cows, sheep, and swine, eat it; and bees are very fond of the flowers: it is, therefore, though a corn-weed, a good pasture plant. It is said to be common in the vale part of the county of Gloucester, in the arable lands; and it has been suggested, that if the seeds did not afford an unpleasant taste to the flour of wheat with which it may happen to be mixed, it might probably be cultivated with advantage, as all domestic animals are fond of it in some degree. See *TRIFOLIUM Melilotus officinalis*.

Sow-thistle is a very common and troublesome weed in tillage-land: it is a perennial, and common among corn-crops in some districts; which, in all cases, when it happens to be so abundant, should be drawn up by the hand or other

proper means before it ripens and spreads its seeds; which, as being furnished with a feathery down, would otherwise fly over the whole country and district, as has already been seen. See *SONCHUS Arvensis*, and *THISTLE*.

Common thistle, cursed thistle, or sow-wort, is, in many cases, a troublesome and disagreeable weed in and about corn-lands and crops. It is commonly called thistle, growing almost every where: when injurious in corn-crops, it may, it is said, be weakened and reduced by good tillage and weeding, but not totally destroyed, in perhaps these or any other ways, otherwise than by universal agreement to root it up, before its seeds ripen and become spread, or by some regulation of police enforcing the same. This mischievous weed is produced by its numerous fibrous roots, which are hardy and strictly perennial, and which if separated in parts or pieces in ploughing, digging, or working the land, each part will, when left fresh in the soil, often grow or vegetate, and produce a new plant; and by its still more numerous seeds which are feathered, will fly and be carried to a great distance by the wind; and when it becomes calm alighting upon cultivated land, will there vegetate and rise luxuriantly, so that it would be in vain for any person to attempt clearing his land of this weed, unless his neighbours did the same likewise: however, the roots of this weed may, it is said, be pretty effectually destroyed by a well-managed summer-fallow, as they will not survive repeated ploughings up in hot weather; and if due attention were bestowed to prevent the seeding of the weed, its numbers might be diminished very greatly: it is found very hurtful to all field-crops. Some think it easily conquered, however, by proper management and attention in tillage-lands, and that it may either be drawn by the tool for that purpose, or be cut off deep by the hoe or speed-hook.

It is supposed, on the authority of the *Flora Rustica*, that the goat and the ass will eat it; that horses will sometimes crop the heads while young and tender; but that no other sort of cattle touch it growing. That when burnt, it is said to yield a very pure vegetable alkali. See *SERRATULA* and *THISTLE*.

Spear, bur, or boar thistles, are weeds of a very pernicious nature in corn-lands, in many instances and parts of the kingdom. They are said to be called by the last of these names in Staffordshire, to distinguish them from the above weeds, which are likewise termed thistles. There are several sorts of them, and they often abound about the hedge-sides and borders of corn-fields, whence they should be rooted up after rain as much as possible, before their seeds ripen and are ready to spread, otherwise such seeds are liable to fly all over the country, as has been seen: these are weeds that grow very luxuriantly, drawing much from the ground or soil, when among the crops, as is frequently the case in many places. They should always be drawn out as much as can be done in such cases in hot weather: they are mostly weeds of the annual or biennial kinds. It is said by Withering, in speaking of the uses of them, that should a heap of clay be thrown up, nothing would grow upon it for several years, did not the seeds of the spear thistle, wafted by the wind, fix and vegetate thereon; that under the shelter of these, other vegetables appear, and the whole soon becomes fertile.

They are never to be trusted among crops, but be kept well cut or pulled up in their early growth. See *CARDUUS Lanceolatus*, *Pratensis*, and *Acaulis*. Also *THISTLE*.

Colt's-foot is a weed that is very apt to abound in hard tilled land. It has been said that the only time to destroy this weed, is by cutting it up in those months when it begins to throw out its flower, at which time, if so cut, it

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will bleed to death; these months are February and March, at which time all land in fallow, which is subject to this weed, should undoubtedly be ploughed and harrowed down, which would, without doubt, check the growth of, and very much weaken the weed; but when neglected at this period, it will soon afterwards ripen its seeds, which furnished by nature with feathers, fly all over the country, and establish themselves very quickly on cultivated land, and banks of earth newly thrown up. This weed may, it is said, be considerably weakened by repeated summer ploughing, and be afterwards, for the most part, weeded out by hand, as the ground is thus rendered light. It is a weed which in Gloucestershire is not found, except on soils that are poor in their nature, and subject to moisture. The obvious remedies are consequently fertilization by manure and the removal of wetness by draining. See *TUSSILAGO Farfara*.

Groundsel is a mischievous and troublesome disgusting weed, not unfrequently found in fallows, on good free soils rendered fine by cultivation, as its seeds ripen quickly in such cases, and fly over the country with the wind: it is a weed that should be got quit of in time by being pulled out, or turned under by the plough, and the seed of it be by no means permitted to ripen and disperse. See *SENECIO Vulgaris*.

Corn marigold, goulans, goul, or buddle in Norfolk, is an extremely troublesome weed in some soils: it is an annual, producing seeds plentifully, which vegetate whenever the land is cultivated, and very commonly in the crops of corn: it would, without doubt, it is supposed, be destroyed, as other annual feeding weeds, by early and complete fallowing to bring the seeds into vegetation in due time, and afterwards ploughing them under. According to Withering, in Denmark, there is a law to oblige the farmers to root it up: and it is said to be stated in the second volume of the "Statistical Account of Scotland," that the late sir William Grierson, of Lag, held *goul* courts as long as he lived, for the purpose of fining such farmers on whose growing crop three heads or upwards of this weed were found; and it has been observed, that some regulation of police for fining those who harbour weeds, the seeds of which may be blown into their neighbour's grounds, has no injustice in the principle of it.

It is stated in the Berkshire Corrected Report on its Agriculture, that it may be destroyed by the application of chalk as a manure, as well as by extirpation.

On the authority of the *Flora Rustica* it is noticed, that if this weed be cut when young in flower, and dried, horses will eat it. See *CHRYSANTHEMUM Segetum*.

Corn mint is a weed that is said by the writer of the Corrected Report of the Agriculture of the County of Gloucester, to be common on damp soils; and that it increases fast by the root, where, for want of frequent ploughing, dragging, and other tillage, it is neglected. See *MENTHA Arvensis*.

Corn camomile is a weed that is sometimes prevalent in corn-fields: it is very prolific in seeds, which should never be suffered to shed, as in that case it would be multiplied to an almost endless degree. See *ANTHEMIS Arvensis*.

Stinking May-weed is a plant of this kind that is common in corn-fields among the crops, but which is often confounded with the above and other weeds of that sort, from which it is to be distinguished by its disagreeable smell: it is very injurious to corn-crops, and should be prevented or destroyed by good fallowing, or by being timely rooted out of the land. The Gloucester Report on its Agriculture states, that maithe or mathern there often overruns a whole field, particularly when planted with peas, so that only the

white blossom of the weed is to be seen. The only chance of destroying this stinking weed is, it is supposed, by the drill husbandry, where room is left for the free use of the hoe. In the broadcast mode the weeds must be pulled out by the hand, which is not only tedious, but, in some measure, dangerous, as there is a noxious quality in the plant which is liable to injure the hands of the weeders, if they happen to have fores on them. See *ANTHEMIS Cotula* and *MATRICARIA Chamomilla*.

Blue bottle is a weed that is common in corn where the tillage of the land has been imperfect, or too long carried on, and continued without cleaning by means of turnips or fallow: it is an annual weed with a somewhat elegant blue flower. It is very common in the corn-fields of Shropshire and Lancashire, as well as in some other counties. It is said that, in Gloucestershire, blue bonnet, knapweed, or corn flower, is a weed common in some fields, principally where the soil is loamy and mixed with pebbles. It is advised to be extirpated at first by the hoe, and, when grown to blossom, by the hand. See *CENTAUREA Cyanus*.

Great knapweed is a perennial corn weed, growing in tufts of many stems or stalks from the same root; and which is to be destroyed in the fallow, or by being weeded out of the crop. See *CENTAUREA Scabiosa*.

Pansy is an annual flower weed that is often found among corn-crops in different districts, where it is produced by seeds that have not been destroyed in the preparation for the corn-crop. It is seldom very hurtful, but when abundant should be weeded out in some way or other. The beauty of the colours of its flowers has gained it a place as an ornamental plant. See *VIOLA Tricolor*.

Corn horse-tail is a weed often met with in corn-land, the fertile stem of which appearing early in the spring, with that of colt's-foot, and decaying before the other part of the plant appears. The author of the paper already noticed states, that Loefel says, if ewes in lamb eat it, abortion is the consequence; but it is believed that sheep or cows will not eat it, unless compelled by hunger. It is to be destroyed by the same kind of tillage and extirpation, as that recommended for colt's-foot. In the Gloucester Report on Agriculture, it is stated to be found only on moist soils, and cannot be easily overcome, but by draining and completely removing the wetness. See *EQUISETUM Arvenfis*.

Fern is a weed not uncommon in corn-fields on dry sandy land: it is a hardy perennial plant, tenacious of growth, and striking a long tap root into the ground, beneath the reach of the plough, which shoots up vigorously when the sun becomes powerful: it prevails largely and strongly on some deep dry hazel loamy soils. In order to destroy it, after soaking rain, it should be drawn or deeply ploughed up; though, in some cases, it will require much pains and attention to get quit of it, especially on land where it has been established for a great length of time. See *PTERIS Aquilina*.

There are different other weeds which are occasionally met with in lands of this sort, but which, as their nature, habits, and effects, have not been well or fully ascertained, they have not been noticed here.

Weeds injurious in Meadow and Pasture Lands.—From its not having yet been fully and exactly decided which are to be considered as noxious and hurtful, and which beneficial and useful plants, in the herbage of grass-lands, it may be proper and of utility to consider them under the heads of such as are really found prejudicial in such situations, and such as have not been discovered to be actually so, and the particular qualities of which are not well known.

Of the first sort are those which are described below, on the authority of the writer of the paper on weeds mentioned above, and that of some others.

Cotton grass, hare's-tail, or moss crops, are weeds that grow in bogs or boggy meadows; and with the down of which poor people stuff their pillows, and make the wicks of candles. This weed is a certain indication that drainage has been neglected, and that it is of course necessary to be attended to and practised, in order to restore the meadow or other such land to the proper state for the growth of good herbage. See *ERIOPHORUM Vaginatum*, and *Polyflachion*.

Hog weed, or cow parsnip, is a weed often found in meadows, but which is too coarse and of too weedy a nature and appearance to be suffered to abound in well cultivated and managed grass-land, though, it is believed, that cattle will eat it either green or in the state of hay: it is thought that it may probably be weakened or destroyed, by annually cutting up in its early growth. See *HERACLEUM Angustifolium*, and *Sphondylium*.

The latter is frequently met with, especially in moist meadows in Cheshire.

Wild cicely, or cow-weed, is a common weed in orchards, hedges, meadows, and pastures. Cattle are said to be fond of it in the spring, but it is too coarse to be permitted or encouraged among good herbage of the grass kind; and as it flowers, and ripens its seeds before the grasses, it is a bad and improper addition to the grass-plants of both meadow and pasture lands: it is frequent in the meadows of Cheshire. It has been suggested, that this and the last noticed plant may probably be worthy of a trial in cultivation by themselves, as being of luxuriant growth, they would yield a large produce: their value has not, however, yet been fully ascertained; nor especially in this method of culture and management. See *CHEROPHYLLUM Sylvestris*.

Garlick, in the wild state, is a weed that is frequently found in meadows and pasture lands, and which is considered as greatly injuring the latter when used for cows. It is said to give a disagreeable flavour to the produce of the dairy, as butter and cheese, but it does not seem that cows much dislike or refuse to eat it. It is supposed, however, that this may probably happen on account of its being so much blended and intermixed with the other grasses, that they cannot avoid cropping it a little. This weed is frequent in the cow pastures of some parts of Lancashire, Gloucestershire, and most probably many others. See *ALLIUM Ampeloprasum*.

Ramson is a weed that is found in some meadows and other grass-lands, but more commonly in the hedges; other plants will not, it is said, flourish near it: cows eat it, but it, like the above weed, gives their milk and its produce a garlic flavour: it should, of course, be weeded out of grass-lands as soon as discovered and be destroyed. See *ALLIUM Urfinum*.

Rushes of different sorts are a sort of weed-plants which are not unfrequently met with in meadows and pastures, especially when of the cold clayey kind, and which are a sure indication that the land, in such cases, wants the superfluous wetness removed; which, when it has been effected, always gives way to better herbage, though their extirpation and destruction afterwards will be promoted and accelerated by top dressings of ashes and other matters. In the Gloucester Report on its Agriculture, it is stated, that the common rush is an inhabitant of soils that are moist and strong, that it abounds in the furrows of pasture-lands, and on the *meers* or strips of grass-land left between the grounds in the vale of that county, as the dividing mark of different

properties, and that it is destroyed in the manner above. See *JUNCUS*, different sorts. Also *RUSH*.

Docks are weeds that are found in strong four heavy land of the meadow and pasture kind. As these weeds are refused by most sorts of domestic animals, they should be rooted up after rain, and every pains be taken to destroy and remove them from grass-land, which they injure greatly by their shade, and by causing the herbage about them to become rank. They are said to be eaten only by fallow-deer, by which their flourishing in parks and pleasure-grounds is prevented. It is remarked that in Gloucestershire docks are extremely injurious to the herbage of pasture-lands, but that if taken in time they may be easily conquered. If, however, they are permitted to ripen, they leave an immense quantity of seed for future crops; and, that being perennial, the evil is increasing in such a multiplied proportion, as almost to exclude the growth of all other plants. In a large meadow adjoining the county-town, these weeds have matured and shed their seeds, it is said, so often, and for so many years, that, at the time of mowing, the whole appears like a crop of docks. Where these weeds are not got up by the roots, it is useful, in some cases, to cut through the stalks under the ground; and to repeat the practice as shoots are again thrown up. See *RUMEX Crispus*, *Acutus*, *Obtusifolius*, &c. Also *WEEDING Dock-Spit*, &c.

Bisfort is a weed that, in some places, occupies large portions or patches in meadows, to the injury and destruction of better herbage: it is a perennial, but may without doubt be weakened or destroyed by rooting up repeatedly. The root is one of the strongest vegetable astringents, and may probably be applied to many purposes in the arts with benefit. It is the inhabitant of moist meadows in Cheshire. See *POLYGONUM Bisfortia*.

Wild campions are weeds often found abundantly in pastures formed from ploughed lands: there are two sorts, as those with white and red flowers. Care should be taken to exterminate them from such pastures by proper following the land when in the broken up state. See *LYCHNIS Dioica*, &c.

Goose-tansy, silver-weed, or feathered cinquefoil, is a weed common in many pastures laid down from the arable state, but generally untouched by cattle: it should therefore be destroyed and got rid of in the tillage state of the land, and by keeping it free of stagnant wetness. See *POTENTILLA Anserina*.

Tansy is a weed that is found in Gloucestershire, in some pastures by the side of the Severn, and in a few other places in that county, but not in abundance, as well perhaps as in some others, especially in the northern parts of the kingdom. It is an unpleasant weed, it is said, which should be eradicated by the spade, or some other proper means. See *TANACETUM Vulgare*.

Pilewort is a weed that flowers very early in the spring, and abounds in shady or moist pasture ground; it sometimes occupies much room in some meadows, and clinches other plants which grow near it; and not being eaten by cattle, it should certainly be extirpated: nothing discourages its increase more than coal and wood-ashes, the writers of the *Flora Rustica* suppose. See *FICARIA Verna*, and *RANUNCULUS Ficaria*.

Lousewort, or red-rattle, is a weed found in moist meadows and pastures, and, it is thought, rarely but where the land is in want of being rendered dry: it is said to be very disagreeable to cattle, and injurious to sheep, giving them the scab, and occasioning them to be overrun with vermin: it is believed, however, that these injuries are principally caused

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caused by the unwholesome nature or state of the land on which it grows: it may be destroyed, it is supposed, by removing the wetness and top dressing. See *PEDICULARIS Sylvatica*.

Yellow-rattle is a weed that is said to grow generally in moist meadows in the county of Gloucester, and which ripens its seeds, and sheds them before the time of mowing, when the dry husks make a rattling noise under the scythe: at this time, it contains no nutritious juice at all, though, when green, oxen and horses will sometimes eat it rather eagerly, and at other times refuse it. Having, however, no desirable quality to recommend its cultivation, and oftentimes overrunning large patches of ground, it should be eradicated and destroyed; and being a biennial, this, it is thought, may easily be done, by grazing the land for three or four years in succession, and taking care that the stalks that are left by the cattle be skimmed off by the scythe before they are ripe enough to shed their seeds, or while they are in full blossom. In regard to its removal, it is stated, that a farmer near the northern borders of the same county, shewed the writer a sloping piece of grass-land which had been overrun with rattle: without any view to the destruction of that he conducted the water of an adjoining stream, as well as he could, over the piece which was not, however, wholly watered; but it proved that on the watered part, the rattle was destroyed, while it continued to grow on the portion which had escaped. No plant is more frequently found mixed with the grasses in the meadows of Cheshire than this; but as it has nothing to recommend it, and the farmers dislike it, the removal of it should be effected to make way for better herbage. See *RHINANTHUS Crista-galli*.

Dyer's-broom is a weed that is seen very abundant in some pastures on strong and moist land, whence, as it is often troublesome, it should be grubbed up, and be got quit of. Wood waxen, dyer's-weed, or base broom, grows abundantly, it is said, in many parts of the vale of Gloucestershire, but generally on dry pastures: it is refused by no cattle but sheep; yet, being inferior to good grasses, should be rooted out, except in places where, as in the neighbourhood of Bristol, it is collected and carried while in full blossom to the manufacturers, who, by boiling and other means, extract a fine yellow colour from it. See *GENISTA Tinctoria*.

Rest-barrow, or commock, is said to be a weed often found in pastures, where it is eaten by cattle, especially the younger shoots of it; but that it is too coarse and rubbishy to be suffered to increase, and should consequently be rooted out or grubbed up as soon as possible. In Gloucestershire it is said, too, to be a most troublesome weed, and a pretty sure proof of want of attention, culture, and manure; as by the two former it may be easily cleared from arable land, as has been seen, and by well-rotted horse-dung even pasture-lands may be assisted; but that rather than such a disgusting plant should continue to grow, where its place might be supplied with good herbage, neither labour nor expence should be spared. The little advantage it gives to sheep, which will eat the young shoots before the prickles are formed, is not, it is supposed, a sufficient inducement in the calculation of a good farmer to leave it undisturbed. In the parish of Elmore, in that county, there is, it is said, a pasture-ground almost covered with it, which lies too far from the farmhouse to have manure easily conveyed to it. In this case, the occupier tried the experiment of drawing it out by the roots, but discontinued it from the idea that it came up with greater strength, and in more abundance the succeeding year. The fact is, that the business is but half done, if the roots are not entirely removed, as every broken piece will

throw out shoots; and from long continuance of the plant on the spot, and the annual shedding of the seeds of it, it is probable that a new crop will arise in the following spring: but the farmer should not be discouraged, it is said, on his first attempt; since, by continually watching the weeds in their early growth, and cutting them off with the hoe, they would gradually be destroyed; and the process would be much assisted by well dressing the places with rotten horse-dung, as suggested above. See *ONONIS Spinosa*, and *Arvensis*.

Common thistle is a most noxious weed among grass herbage: it has strong roots which shoot out in a lateral manner, and is a perennial plant of vigorous growth in some soils. It may be got quit of by cutting it off within the ground, or by being rooted up; for the former sort of work the best time is when the plants are coming into full blossom, as they then become soonest rotten and destroyed in their hollow root parts; and for the latter in pasture-lands when the ground is well soaked with rain, and they can be drawn easily. They are sometimes very hurtful to the hay lands in the vicinity of the metropolis, where the management is bad. See *SERRATULA Arvensis*, and *THISTLE*.

Rough large thistles, or boar-thistles, are weeds of a very troublesome nature among grass-crops, and which are always to be got rid of without delay. They are generally mown or otherwise cut over, but are much better rooted or drawn up. It is remarked by the writer of the *Corrected Account of the Agriculture of the County of Gloucester*, that thistles of all kinds are very unpleasant weeds in grass-lands; either when green or dried with the hay, they annoy the cattle in feeding, and consequently should never be permitted to grow long on any such land; to prevent their growing at all, is, it is thought, perhaps impossible, but the increase of them may be checked by early attention: while, however, they are left to be mown with the grass, or to remain undisturbed in the highways during the summer, the seeds will be dispersed by the wind in various directions over the country: until a method be therefore adopted to correct the evil in its infancy, the labour bestowed by good farmers for the extirpation of this weed will not, it is said, produce a complete effect, although it will prevent the plant from being carried to the mow in a state of equal maturity with the hay, and its seeds afterwards from being dispersed with the dung in the fields. Was every farmer to do the same, the encouragement to persevere in the practice would be powerful; but that it is not probable, that a farmer will expend much in doing what the negligence of a neighbour will render ineffectual. Some of these thistle-weeds are annual, others biennial and perennial; consequently, where the distinction is not known, the safe method is, it is said, to cut the root with a paddle, deep in the ground, or to draw up the root; and that this should be done for the first time in the spring, and again on the lattermath in autumn. See *CARDUUS Lanceolatus*, &c. Also *THISTLE*.

Cudweed, or chafeweed, is a weed said not to be uncommon in pastures from arable land. It has been seen abundantly in an upland pasture after barley, where the clover had failed of success; cattle refuse it, but it has been supposed to be successful in the bloody flux of cattle and of the human species: it seldom appears much in a grass-crop, or especially when the artificial grasses succeed well. See *GNAPHALIUM Germanicum*.

Ox-eye, white marigold, or great daisy, is a weed common in some pastures, and not grateful, but which seldom abounds so as to be much injurious to the grass, and which is easily drawn out by the hand or other such means. See *CHRYSANTHEMUM Leucanthemum*.

Black knap-weed is a common and abundant weed in some moist and cold meadows and pastures, where it is a very bad plant, being coarse, hard, and stubborn, seldom touched by cattle, either in the green or dry state, and not extirpated from the ground without much difficulty: it is a perennial weed, which increases much by the root, according to the *Flora Rustica*. It is supposed that it might probably be much weakened and reduced, and be extirpated by degrees by drawing up after rain. It is stated too, that in Gloucestershire the common black knap or knob-weed, provincially hard heads, is a vile and worthless weed, which cattle of no kind will touch, in any state; and yet it is suffered, on some pastures, to grow and increase to such a degree, as to exclude the appearance of almost every other plant, and, though useless, is mowed with the other herbage, and preserved for winter fodder. That it is a weed which indicates poor land, though probably, by the use of soaper's ashes, it might be conquered, otherwise the ground should be ploughed up and converted to a better purpose. The writer of this article lately saw it wholly covering a poor pasture field in the north of Lancashire, to the exclusion of all useful grasses. See *CENTAUREA Nigra*.

Sedge-grasses, various sorts, are weeds that are most common in cold, old, sour, moist clayey lands of the meadow and pasture kind, undrained and unimproved; in which they are said, in some places, to occupy the whole surface: they are extremely hardy, and flourish where scarcely any thing else will grow: seem produced by nature from this principle in her economy, that a bad plant is better than none, for these plants are not eaten by any sort of cattle which can get any thing better; yet, upon getting quit of the superfluous moisture or wetness, and top-dressing the land, it will commonly give way to a finer and more valuable herbage. See *CAREX*.

They have provincially the titles of hard-grafs, iron-grafs, and carnation-grafs, sometimes applied to them.

Common nettle is a weed sometimes growing in tufts on pasture-land, where it should always be rooted up, as it will prevent the growth of good herbage, and render the grass rank near it: asses are said to be fond of it, and cows eat it in the state of hay. See *URTICA Dioica*.

Mosses, various sorts, are weeds that are sometimes said to spread on pasture and other grass lands, and, it is believed, indicate that the herbage is starving and torpid, and stands in need of a stimulus to quicken its growth: proper top-dressing should be used, and the wetness be removed, if necessary. Treading by sheep, and scratching the surface by means of fine-teethed implements, have likewise been found of great utility. See *MUSCI*, and *Moss*.

Such plants as the above must be considered as proper and necessary to be extirpated from grass-lands of most kinds; but there are various others which are of less importance, and the characters of which are more doubtful, and their uses not so well determined and decided upon.

Of this latter sort or class, the following may be noticed as being mostly improper in such situations.

Crowsfoots, butter-flower, butter-cup, king-cup, or gold-cup, are plants almost every where found in meadow and pasture lands. The pile-wort is common in some places, and the bulbous-rooted sort, it is observed, has knotty roots, rises little above the ground, blossoms early in the spring, and is chiefly found in meadows that are rather moist, being eaten only by sheep. The other sorts are common in the meadows and pastures everywhere, being very abundant in the hay-grounds near the metropolis. Their good qualities in such lands have been much questioned and disputed by many; but the writer of the paper already noticed is inclined

to think favourably of them, especially as promoting the digestion of the live-stock that feed in such pastures; and as not having been discovered to be injurious in such situations by farmers in their long experience. The writer of the Gloucester report, however, states, that the several sorts of crowfoot, provincially termed crazys, which in the spring throw a yellow veil over the meadows, are to be reckoned among the useless weeds, having little to recommend them to notice but their gaudy appearance. That the three latter sorts are acrid and biting to the taste, and are therefore rejected by cattle nearly alike. It is indeed said, that the creeping crazy is more mild and palatable to some cattle, though it is to be suspected that cattle eat it rather from necessity than liking; as from its spreading along the surface, it becomes so matted with the herbage, that it must be taken up, in some degree, with it. The stalks of the two others are left standing when the ground is quite bare about them; yet, when made with the hay, they are said to lose the pungent quality; and the brightness of the blossom in the rick, is always a sign of the whole having been well harvested.

All the sorts of this tribe of plants, though pleasant to the eye in meadows and pastures, in consequence of their display of yellow flowers, are, it is said in the Berkshire report, injurious to the herbage, and little relished by animals of any kind. Although difficult to be eradicated, some of the larger sorts of them may be reduced greatly by proper care and attention. See *RANUNCULUS Ficaria*, *Bulbosus*, *Repens*, and *Acris*.

Wild mint is a plant found in moist pastures, and which prevents the coagulation of milk; so that when cows have eaten it, as they are apt to do largely at the end of summer when the pastures get bare, their milk can hardly be made to yield cheese; a circumstance which occasionally puzzles the dairy-maids. It is a plant that should be removed from pastures, and which, it is supposed, may be weakened by effectually removing the wetness of the land. See *MENTHA Arvensis*.

Marsh marigold is a plant that occupies much space, and which is dangerous to cows. It should consequently be removed from pastures and other grass-lands. See *CALTHA Palustris*.

Water hemlock is a plant supposed poisonous to horses, and should therefore be eradicated from pasture-lands. See *THELLANDRIUM Aquaticum*.

Water cowbane, meadow-saffron, and treacle-mustard, are plants in pasture and grass lands, that are said to communicate an unpleasant odour to the milk of cows, and to be sometimes fatal to them. When abundant they ought to be removed from such lands. See *CICUTA Vireosa*, *COLCHICUM Autumnale*, and *THEAPSI Arvensis*.

Mouset-ear scorpion-grass is a plant that often proves fatal to sheep, it is said, and should of course be extirpated from sheep-walks. See *MYOSOTIS Scorpoides*.

Rag-wort is a plant in grass-land which cows and horses refuse, and which sheep will only eat when very young: it is a plant that is stated, in the Cheshire Report on Agriculture, to be regarded as worse than useless both in meadows and pastures. That it frequents rich soils only; and that the farmer there often exhibits the keddle-dock, as it is provincially termed, as a proof of the goodness of his land. That while his vanity is flattered by its presence, he not only neglects to extirpate it, but frequently suffers it to spread over one of his best pieces of land, to the injury of himself and the annoyance of his neighbour. It is said that by mowing it is prevented from propagating its seeds; but that the roots are not destroyed. That this is best effected either

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either by eating it down while young with sheep, or pulling it up by the hand. This last should be done when the ground is moist, in order that no considerable fibres may be lost or left in the land, as if there are the roots will strike again. See *SENECIO Jacobæa*.

Meadow sorrel is a plant common in meadows, and especially where the soil is strong and rather wet: it is a coarse plant that is injurious by its shade, and seeds in good grass-lands. See *RUMEX Acetosa*.

Wood or meadow anemone is a plant common in meadows, though disregarded by farmers; the whole plant is said to be acrid. Withering asserts, that when sheep that are unaccustomed to it eat it, it brings on a bloody-flux. See *ANEMONE Nemorosa*.

Eye-bright is a plant common in pastures, and refused by cattle in general; consequently occupying the place of a better plant. See *EUPHRASIA Officinalis* and *Odontitis*.

Dandelion is a disagreeable plant, though common in grass-lands in most districts: it is said to be considerably diuretic, and on that account may probably have a good effect on cattle at first going to grass: it is coarse, but good in hay with grasses. See *LEONTODON Taraxacum*.

Yarrow, and *sneeze-wort*, are plants common in pastures, but indifferent to cattle-stock. The former has been recommended for poor land. The common yarrow has been found plentifully intermixed with the herbage in the vale part of the county of Gloucester, where much fed with horses. Some have, it is said, supposed, that cattle are not averse to it; but it has been observed, that this weed has remained uneaten until every blade of grass has been cropped close to the ground, and therefore that it should be extirpated by the spade or some other means, such as the three-pronged fork, at the expence of manual labour. See *ACHILLEA Millefolium* and *Piarnica*.

Orchises of several sorts are plants that are common in most meadows, having broad, entire, spotted leaves in general, and large bunches of pale or purple flowers. They generally remain untouched by most, or all sorts of cattle-stock. See *ORCHIS Maculata*, *Bifolia*, &c.

Plants of this sort have hitherto been much too little examined and inquired into, in so far as relates to their utility and importance, or the contrary, for the uses of the farmer, to afford any thing satisfactory on the subject; but that a great many such plants should be rooted out of grass-lands of different kinds there can be no sort of doubt. This would render the meadows and pastures much better for the purposes of hay, and the pasturing and feeding of live-stock of every sort, and be greatly beneficial to the farmer in many ways.

Weeds injurious in waste and uninclosed Lands.—It is stated by the writer of the paper on weeds, that those considered as particularly hurtful to such land, are not very numerous; for though many sorts of plants, useless as the food of domestic animals, grow there, yet, as there is no possibility of introducing any thing better until such lands are appropriated and improved by cultivation, they can hardly be conceived as noxious, so long as nothing better can be put in their stead. That, as such lands in their present condition are useful only as sheep-walks, or for producing fuel, the bettering of them, in the former respect, is an object deserving of attention, particularly as such amelioration would render them of greater value in case of inclosure, and would much shorten the business of bringing them into the state of improvement. See *WASTE Land*.

The weeds that encumber such lands, and reduce their value as sheep-walks, are considered as of two kinds; the common upland rubbish, and the bog produce of plants:

the former smother the land, so as to prevent the growth of better herbage; and the latter are generally hurtful to animals that feed on them, either from their own nature, or because the land on which they grow is uncomfortable for and unwholesome to the health of them, especially to sheep.

Upland weeds are all those that rise in high barren situations, and which chiefly consist of heaths of different sorts; furze or gorse, the petty whin, or hen-gorse, and broom, but which is more commonly met with in neglected dry lands of the arable kind: these should all, it is said, where the ground is of tolerable staple, or depth of mould, be burnt off, or grubbed up, early in the spring; and if the land be afterwards sown with grass-seeds of the hay kind in moist weather, it will much improve the herbage: the fern should also be mown, and carried off in the summer, the value of it as litter being well worth the labour and trouble. See *ERICA*, *ULEX Europæus*, *GENISTA Anglica*, *SPARTIUM Scoparium*, and *PTERIS Aquilina*.

Bog weeds are those that arise in swampy places, and are caused by stagnant moisture or wetness, being principally cotton grasses, matt-grass, rushes of several sorts, red-rattle or louse-wort, marsh, St. Peter's-wort, kingspear, which last two are of but little consequence in themselves: they, however, indicate boggy land; and in their company are often found purple-flowered money-wort, sedge grasses of several sorts, &c.: all which would give way to better herbage, upon the stagnant wetness of such bogs being removed, which should, it is said, be done by a rate, levied on the inhabitants of the neighbourhood, having right of common upon such wastes. See *ERIOPHORUM Polystachion* and *Vaginatum*, *NARDUS Striata*, *JUNCUS*, *PEDICULARIS Sylvatica*, *HYPERICUM Clodes*, *NARTHECIUM Ojifragum*, *ANAGALLIS Tenella*, and *CAREX*.

The disease, termed the rot, in sheep, which so commonly arises in these situations, has been often attributed by stock-farmers and others to the fun-dew, marsh penny-wort, and common butter-wort, weeds found in such lands; but it is more probably caused by the flat insect known by the name of fluke, *fasciola hepatica*, which is not unfrequently met with in such watery grounds, sticking to different parts of the plants, and which has been discovered in the diseased livers and bile ducts of sheep thus affected. See *DROSEREA Anglica*, *HYDROCOTYLE Inundata*, &c.

The writer just noticed suggests, that if the country should not yet be ripe or ready for inclosing all the commons and waste lands, the improvement of their staple by measures of this kind, by destroying weeds and introducing better herbage, by removing the wetness of the bogs, and destroying the aquatic weeds growing thereon, would better their present state, and improve their value to the public, would render them capable of maintaining a greater number of better sheep, and preserve the stock in better health, as well as render the land more susceptible of a rapid and easy improvement by cultivation, whenever the time may arrive for their inclosure, and for such full amendment of their condition.

Weeds injurious in Hedges and other such Fences.—It is remarked in the paper on weeds and weeding, that all kinds of them are hurtful to young hedges, which constantly require to be well cleaned and freed from them for three or more years after planting, as otherwise the young quick or other plants would be choked and destroyed; and that there are also some kinds of weed-plants which very much injure old full-grown hedge-fences. That many kinds of weeds growing in hedges are a great nuisance if the seeds be suffered to ripen, because such seeds are liable to be carried into cultivated

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cultivated land by the wind; that there are some kinds of hedge-weeds, too, which bear the character of being injurious to live-stock; these, if the observation be well founded, ought, it is said, to be well cleared from the hedges that such stock frequent; and that, lastly, the improper species of the vegetable kingdom, composing or growing in hedges, may be termed hedge-weeds, because they prevent the main object and end of such hedges, that of dividing, fencing out, and defending the land in a proper manner.

The most hurtful weeds and plants of this sort are,

Catch-weed, or cleavers, a weed that has a tendency to choke and injure young hedges, by means of its numerous creeping and twining rough branches: it should, of course, be well cleaned out in due time, before it spreads itself much in the bottom of the fence. See *GALIUM Aparine*.

Great bind-weed is a plant of this sort that is injurious in some hedges, by twining round the growing quick or other plants, and restricting their growth: its roots should consequently be extirpated from such situations, which may probably be worth collecting for medicinal uses, as the inspissated juice of them compose scammony, a powerful purgative remedy. It is eaten greedily, too, by hogs without injury. See *CONVOLVULUS Sepium*.

Great wild climber is a weed-plant common in hedges, and which, in the chalk counties, is said provincially to be called old man's beard, from the hoary appearance of the plant after flowering, the seeds being furnished with numerous grey hoary tails. It is very injurious to hedge-fences, as the leaf-stalks twine about any thing they can lay hold of, and thus support the plant, which is large, luxuriant, and heavy, without any strength to support itself, and by its weight hauling down, obstructing the proper growth, and deforming the fences of this kind. Withering remarks, that the fine hairs that give the cottony appearance are, he apprehends, too short to be employed in manufacture, though, it is probable, they may be used to advantage for the stuffing of chairs. See *CLEMATIS Vitalba*.

Wild hop, ladies' seal, or black bryony, and wild vine or bryony, are all weed-plants common in hedges, where they are supposed to be somewhat injurious to the hedge-fences. They do mischief in these situations, by crowding and smothering up the hedge-plants, and preventing their healthy and vigorous growth, as well as by taking away the proper nourishment from their roots. See *HUMULUS Cupulus*, *TAMUS Communis*, and *BRYONIA Divica*.

There are other spreading, twining, and climbing weed-plants, which are occasionally very injurious and troublesome in hedges; such as the common ivy, which spreads and creeps on the banks, and runs up and winds round the stems of the plants, greatly injuring and impeding their growth and strength; the honey-suckle, which binds itself closely about the stalks and branches of the hedge-woods, doing them much injury in different ways; and the briar, which extends its rampant shoots in various directions, to the great annoyance and mischief of the hedge-plants in many cases. All these should be eradicated and cleared out from hedges in most cases, as they constantly tend to weaken and render them in bad condition. See *HEDERA Helix*, *LONICERA Periclym nun*, and *ROSA Canina*.

Sow-thistles, large rough thistles, knap-weeds, and ragwort, are weeds that have been already noticed, and are great nuisances in hedges, if their seeds be suffered to ripen in such situations. The common nettle, too, is sometimes found in hedges to their great injury. They should all, therefore, be extirpated and cleared out from hedges in their early growth, to prevent future increase.

In addition to these, the writer of the above paper has

given the following, the seeds of which are furnished with feathers too, and they are capable of being carried to a great distance.

Yellow devil's bit, wild lettuce, yellow hawk-weed, bushy hawk-weed, and smooth hawk's-beard, are weeds often troublesome in hedges, and which should be kept well weeded out at an early period. See *LEONTODON Autumnale*, *LACTUCA Virosa*, *HIERACIUM Murorum et Umbellatum*, and *CREPIS Tefforum*.

Burdock is a well-known plant of the weed kind, that should not be suffered to perfect its seed in hedges, as it is of very luxuriant growth, and of course very injurious and disagreeable in such situations. Withering asserts, that before the flowers appear, the stems, stripped of their rind, may be boiled and eat as asparagus; and that when raw, they are good with oil and vinegar. See *ARCTIUM Lappa*.

Dog's mercury is a weed said to be noxious to sheep, and which is very common and abundant in some hedges, appearing very early in the spring, when sheep-food is the most scarce; on which account it is thought still more dangerous, if it be so at all. When in very large quantity it may be hurtful to hedges, and should be kept under. See *MERCURIALIS Perennis*.

Barberry is a frequent plant in some hedges; if found to really possess a blighting quality, it should be removed from the hedges of corn-fields. See *BERBERRIS Vulgaris*.

It is advised by the author of the above paper, that these, as well as other plants of a similar nature, together with all luxuriant weeds and shoots of the bramble kind, and whatever else grows beyond the bounds of the hedge-fence, should be brushed out of such hedges about the middle of the summer, as is very often done in some counties, as Staffordshire, for the sake of their ashes, which are worth all the labour and expence incurred in burning them, &c.

Weeds injurious in Woods and Plantations of different Kinds.—The weed-plants which are necessary to be considered under this head, are not very numerous: those which are given below are the chief of such as are peculiar to or commonly found in situations of this nature, where no art has been used. They are the most common herbs and plants which are spontaneously produced in woods and plantations without attending to the timber and underwood sorts; but many other kinds are to be met with, which are less common, and which have been less noticed and considered.

Enchanters' nightshade is a weed found in the woods of Bedfordshire, and some other counties, and by no means uncommon. See *CIRCÆ Lutetiana*.

Wood-reed is a weed met with in many woods. See *ARUNDO Arenaria*.

Woodroffe is a weed common in many woods about Enfield, in Staffordshire, and Berkshire. Sometimes very plentiful. See *ASPERULA Odorata*.

Wild angelica is a weed common both in woods and hedges, in many places. See *ANGELICA Sylvestris*.

Solomon's seal, or wood lily, is a weed found in woods in many different parts of the kingdom. See *CONVALLARIA*.

English hyacinth, or hare-bell, and willow herbs, are weeds in some woods. See *HYACINTHUS non Scriptus*, and *EPILOBIUM*.

Bilberry is a weed met with in moist woods in many parts of the country. See *VACCINIUM Myrtillus*.

Wintergreen is a weed-plant met with in the moor-land woods

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woods in Staffordshire, and some other counties. See PYROLA.

Wood-forrel is a weed very common in woods. See OXALIS *Acetofella*.

Wood-spurge is a weed frequently met in woods, situated in a clayey soil. Plentifully in Needwood-forest, in Staffordshire. See EUPHORBIA *Amygdaloides*.

Raspberry, dewberry, and common bramble, are weeds common in most woods, in some of the forts. See RUBUS.

Wild Strawberry is a weed common in some woods. See FRAGARIA *Vesca*.

Tormentill is very common as a weed in some woods. See TORMENTILLA *Reptans*.

Herb bennet, and wood anemone, are common weeds in such situations. See GEUM *Urbanum*, and ANEMONE *Nemorosa*.

Wood crowfoot is a common weed in woods on a clayey soil. See RANUNCULUS *Auricomus*.

Stinking Hellebore is a weed in woods, in many parts of the kingdom. See HELLEBORUS *Eatidus*.

Wood sage, betony, hedge-nettle, and bastard baum, are weeds of the common wood kind. See TEUCRIUM *Scorodonia*, BETONICA *Officinalis*, STACHYS *Sylvatica*, and MELISSA *Melissophyllum*.

Cow-grass, or cow-wheat, is very common in many woods, and said to be an excellent cow-herbage; but little found in pastures, in any situation. See MELAMPYRUM *Pratense*.

Fig-wort, and coral-wort, are weeds in some woods. See CROPHULARIA *Nodosa*, and DENTARIA *Bulbifera*.

Pea-everlasting is a luxuriant weed-plant, that has been seen with the stem five or six feet long, in a wood in Rutlandshire. See LATHYRUS *Sylvestris*.

Wood-vetch, wood-peasling, St. John's wort, shrubby hawk-weed, fow-wort, hoary groundsel, golden-rod, butterfly-orchis, friary-blade, sedge-grasses, and spurge-olive, or spurge-laurel, are all plants of the weed kind in woods in different places. See VICIA *Sylvatica*, OROBUS *Sylvatica*, HYPERICUM *Perforatum*, HIERACIUM *Sabadum*, SERRATULA *Tinctoria*, SENECIO *Crucifolius*, SOLIDAGO *Virgaurea*, ORCHIS *Bifolia*, OPHRYIS *Ovata*, CAREX and DAPHNE *Mezereum* and *Laureola*.

It has been remarked, that as no sort of cattle can be properly introduced into these situations, in the early growth of the woods, there appears no particular room for the choice of the under herbage; but all large coarse growing weeds of these and other kinds, should be removed or kept well under, and that briars and brambles, if they appear, should on several accounts be grubbed up and destroyed. Ivy, too, as clasping, confining, fretting, and injuring the plants on which it rises, should be early cleared away to prevent the mischief of its after removal.

It is hardly necessary to observe, as it must be evident, that this account is far from comprehending all the plants which have been considered as weeds by writers, and those engaged in the cultivation of land; as such as are known to be prejudicial or hurtful, in some way or other, to some sorts of cultivation or other, have, for the most part, been only introduced.

Those who may wish for further information on the subject, may consult the paper on weeds, by Mr. Pitt, inserted in the fifth volume of "Communications to the Board of Agriculture;" and also the new edition of Miller's Dictionary, by Martyn, in which a very large catalogue of weed-plants is given; as well as many of the Corrected Reports on the Agriculture of different Counties.

It is remarked by the writer of the above paper, that the

plants we term weeds, considered as respecting mankind, are not totally useless; many of them have valuable medicinal, and, perhaps, other qualities and properties, and some of them may be applied to uses so as to pay something towards the expence of clearing them from the ground: thus, low-thistles are good for rabbits or hogs, the hog-weed is useful for either pigs or cattle: horses are said to be fond of young thistles when partially dried, and the seed may be prevented from spreading by gathering the down, which makes good pillows; however, there is some danger in trusting them to this stage of growth, as a high wind would and frequently does disperse them over a whole country, as has been seen already. Chadlock, when drawn, may be given to cows, who are very fond of it; and it is said in the Oxford Report on Agriculture, that it can be converted into good hay. Further, that nettles, fern, and the more bulky hedge-weeds, may be collected and annually burnt, as has been seen above; their ashes being afterwards formed into balls, which are of considerable value, as being used in composing a ley for scouring and cleaning linen and other cloths.

It is stated, too, that pigeons are of use in picking up the seeds of many weeds that would otherwise vegetate; and the writer has no doubt but that a prodigious quantity of the seeds of weeds are eaten by different sorts of small birds, particularly of those of most of the lake-weeds, of spurry, and in severe weather, of the different sorts of chadlocks, as well as of many other kinds. But that it has been observed, that bees have not thriven or done so well in this country since the extirpation of weeds has been more attended to, and become more general.

It is noticed, that in Japan, and in China, not a weed, it is said, is to be seen; and that they make use of night-soil only as a manure, partly with the view of preventing any risk of weeds being produced in that way.

In concluding, it may be noticed, too, that the same writer has remarked, that the vegetables we term weeds are more hardy and tenacious of growth than any others; nor can it indeed be otherwise than that those plants, which succeed in spite of opposition, must be of the most hardy kind. But that the production or growth of weeds is equally consistent with the divine goodness with that of the most valuable plant, for myriads of diminutive creatures, enjoying life and animation, are fed and supported by them, and to whom they are a more natural prey than the dietetic plants of mankind: and that man, possessed of reason, reflection, and intelligence, has powers and abilities to select and cultivate such vegetables as are adapted to his use, and proper for his sustenance, and to destroy and extirpate others; and thus to appropriate to himself what proportion he may think proper of the earth's surface; which if he should neglect to dress and cultivate properly, it will, in some degree, revert to its natural state, producing the hardier and more coarse and acrid plants for the sustenance of numberless tribes of insects and other little animals, and for an infinity of other known and unknown uses and purposes; and that indeed were it otherwise, the indolence of the human race might, in some measure, suspend the bounty of providence, and the fertile parts of the surface of the earth, instead of being covered with an universal verdure, would, by inattention or neglect, be rendered little different to the sterile and barren desert.

WEED, *Dyer's*. See DYER'S *Weed*, *Bastard* ROCKET, and WELD.

WEED, *Fuller's*. See TEAZEL.

WEED-HOOK, in *Agriculture*, a very useful implement for cutting up thistles, and other strong plants of the same nature;

ture; but as thistles, when cut either at an early period of the season, or before much rain falls, are apt to spring up afresh, and produce four or five stems in place of one; they should, perhaps in every instance, be pulled up by the roots, or, if they be cut, the operation should be done with a chisel within the ground, which is formed with a division in the mouth of it, so as to seize the stem part of the plant, and cut it deep down. See *WEEDING Dock-Spit*.

WEED, Sea. See *FUCUS*.

WEED, Silver. See *CINQUEFOIL*.

WEEDA, in *Geography*, a town on the E. coast of the isle of Gilolo. N. lat. $0^{\circ} 15'$. E. long. $127^{\circ} 45'$.

WEEDL, a town of the duchy of Holstein; 7 miles S.S.W. of Pinneburg.

WEEDING, in *Agriculture and Gardening*, the operation of freeing crops of any kind from noxious weeds. On the indispensable necessity, and great utility of this practice, it is altogether needless to enlarge. See *WEED*.

There are obviously two different methods to be principally employed in the removal and destruction of weeds; one of which occurs in the preparation of the land, and the other during the growth of the crop. In the former method it is necessary that such weeds as are of the root kind should be distinguished from those of the seedling description, as the destruction and removal of them must be effected in different ways, and upon different principles.

Weeding in garden-grounds is always a business that should be regularly and well performed in both the circumstances above-mentioned. Much may be frequently done in the former case by properly ridging or laying up the ground before the severe winter-season sets in, and in reducing and breaking it down in the early spring or other time, for levelling it, and making it ready for putting in the necessary crop, as the root as well as the seedling weeds may be greatly extirpated and destroyed in these different operations; the former affording the ready means of taking out the first sort, and the latter by putting them in the sprouting state, giving the opportunity of destroying the other. In the latter case, a great deal will be effected by the steady and repeated application of the hoe while the crops are upon the ground; and by good and careful hand-weeding, before the weeds have had time to ripen and shed their seeds.

It has been remarked with great truth, in regard to the extirpation and prevention of garden-weeds, that many will almost constantly appear, from the seeds being brought by the wind; as well as by being introduced by using raw dung, particularly of hogs and horses, which often contains seeds possessing their vegetative power, and the litter intermixed therewith not unfrequently containing more; which strongly shew that raw dung is very improper for gardens, though often used, particularly for early and other potato-crops, as it causes much trouble and expence in weeding.

Much labour in weeding must necessarily be saved, too, by drawing up all seedling weeds in time, as they appear, and before they have sown their seeds.

The extirpation and removal of weeds from garden-grounds are somewhat differently effected in various places: in some they principally use the spade, and the three-pronged or fanged fork, for cleaning out root-weeds; but the different kinds of hoes are employed for other purposes, of which the common ones are mostly made use of for scuffling over the surface, and those of the triangular and parallelogramic form, for cutting up weeds, moulding up and clearing growing plants, and loosening the surface of the ground for promoting the sprouting of any seeds that may be present, and other such uses. With these the scuffle or scuffler is sometimes had recourse to for cutting the weeds,

and working the surface of the land over in large gardens. In the small planted broad-cast sown crops, the weeding can only be well accomplished by performing the work by the hand. See *HOE, FORK, SPADE, SCUFFLE, &c.*

In regard to destroying and removing weeds in tillage-lands, it has been well observed by Naismith, in his "Elements of Agriculture," that when the ground is greatly overrun with weeds, a complete winter and summer fallow will, for the most part, be found unavoidable, in order to get entirely quit of them. Rib-fallowing, before the winter sets in, will, it is said, prepare the soil for parting freely with the vivacious roots, the ploughing and harrowing requisite to tear them up when the spring drought commences, will pulverise and reduce it, and provoke the dormant and inactive seeds to vegetate with the first moisture; by repeated turnings, during the summer, the greatest part may be made to vegetate, and be destroyed as they rise; and the vivacious roots, which lie beyond the reach of the plough, by being long prevented from exercising their vegetating powers, will be impaired in vigour. When winter-wheat, or any crop which is to stand through that season, is intended to be put in on such ground, it would be proper that the seed should be sown in drills, that by stirring the intervals in the ensuing summer, the tendency which moist soils have to condense or consolidate too much when greatly pulverised or reduced in their parts, may be counteracted. If spring-feed be intended, the last ploughing should be given to the land before the winter's rain commences, and the field be accurately and fully surface or furrow-drained, and laid dry. The influence of the atmosphere during the winter will, by these means, communicate the happy medium of consistence, on which so much depends; and the soil, as soon as it gets dry in the early spring, will be in the best order for the reception of the seed at that time, and the weeds the most fully and effectually destroyed and removed.

But where ground has been under any tolerable management, drill culture will, it is said, for the most part, suit all the purposes of a clean fallow, or be the means of rendering the land wholly free of weeds. In repeatedly turning the intervals, most of the annual weeds may be attacked in the group, and be expeditiously destroyed as often as they spring up; and the roots of the perennial ones be turned up and exposed to the heat and drought, which, if not altogether extirpated, will have their progress checked and prevented. But the rows should also be hand-weeded, and the hand-hoe will not unfrequently be found an important implement in this work. Drill culture may thus be partially exercised, in this intention, it is thought, every where with great advantage, adapting the application to any particular situation or circumstances. For example, where alternate courses of tillage and grass crops are adopted, in a course of three years' tillage, the second might always be in the drill manner; or if there were manure to spare, to keep a field in good condition in tillage-crops for four years, both the second and third might be in the drill method: the first on account of the tough turf or sward; and the last for the sake of sowing the land down with grass-seeds would be more convenient in the broad-cast state: but the weeding in these cases should not be neglected; the larger weeds especially; and all those which are most prevalent, and most productive of seed, should be taken out by hand labour, or some such means, when they begin to flower. By such strict care and attention to weeding tillage-land and crops and stocking the ground with proper perennial grasses when laid to rest, weeds would at length be so much subdued, it is supposed, as to be seldom injurious to the farmer.

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The writer of the paper on weeding has stated, that it is remarked by the author of the *Essays on Rural Affairs*, that there is only one mode of extirpating annual weeds, the seeds of which are indestructible; which is to put the ground into such a state as to induce them to sprout or germinate, and then to destroy the young plants by harrowing them up, or ploughing them under. This, it is believed, is strictly true; but the author of the paper just noticed does not exactly agree with the writer of the essays in the process to be pursued for the purpose; the ground, in this intention, in his opinion, should be ploughed before winter, but not harrowed, it being better to lie rough through that season, so as to have the greatest extent of surface possible exposed to the action and mellowing effects and influence of frosts; that, as soon as it becomes dry, in or about March, it should be cross-ploughed and harrowed well down; many of the seeds and roots will then vegetate, which should in due time be ploughed under, and the land harrowed again, and this sort of process be repeated as often as necessary: this, it is said, is the true use and manner of summer-fallow in this view, which, to have its full and proper effect, should always, it is thought, be attended to early in the season, when the powers of vegetation are the greatest, and the heat of the sun is powerful; as under such circumstances the greater number of weeds will be brought into a state of growth.

It is thought that the great defect in the management of summer-fallows in the intention of destroying weeds would seem to be the neglect of working them early in the season, by which omission the vigorous annual seedling-weeds are not brought into vegetation in due time; as, after which, they will not grow until the spring following, when they appear in such abundance among the wheat or other crop, as sometimes to choke it up: this is the reason, it is said, why the field poppy, the corn-crowfoot, the tare, and many other annual weeds, make such havoc among wheat, when by a proper and judicious early working of the fallow, they might have been brought to exhaust themselves in the following summer: this appears very clear from the effect, for if no wheat were sown, the seeds of these weed plants would often fill the ground with a full crop; but seeds can vegetate but once, consequently had this vegetation been brought on in the fallow, and the plants afterwards been ploughed under in due time, none could have appeared in the wheat-crop.

It is supposed, too, that the turnip-culture is peculiarly adapted to the destruction of weeds, as for this sort of crop the ground must of necessity be in early and fine preparation, by which weeds of early growth are conveniently brought into vegetation, and destroyed; and those which remain in the living state in the soil may be exterminated by hoeing. It has been observed by the writer, that wet weather is as necessary as dry to give a summer-fallow its whole effect; for without a soaking of rain after the land is pretty well pulverised, numbers of the seeds of weeds will not vegetate, but remain and grow amongst the crop; the root-weeds are therefore to be destroyed in dry weather, and the seedling ones after rain; and though the land should, after a dry season, be apparently in excellent order for sowing, it will be better to wait the effect of rain, and even give time for the seedling weeds to vegetate, before the seed for the crop be actually sown.

It is, therefore, suggested, that the destruction of root weeds, and those of the seedling kind, on corn-land, must be effected upon different principles, and in different manners; the former, by working them out of the soil in dry weather only; the latter, by pulverising and reducing the particles of the soil, so as to induce the seed to germinate

and spring up fully after rain, and afterwards ploughing under the young plants: also that frequent ploughings and harrowings are necessary, to expose all the seedlings contained in the soil to the powers of vegetation. But it is conceived, that the ploughings and harrowings of fallow ground should not, however, immediately succeed each other; time should be given for the consolidation of the soil, which, after well harrowing, will undergo a slight fermentation, and settle, as it were, into a mass; after which it will turn up mellow, and the destruction of weeds will go on apace. It is thought, that the frequent ploughings, which have been recommended by some, are not only unnecessary, but injurious. It has always been observed, that one ploughing of a fallow too soon succeeding another has no other effect, when used in this intention, than that of rooting about the clods, and preventing the general effect of consolidation and fermentation in the land. The suffering of the weeds to spread their leaves a little between the several ploughings of a fallow, for this purpose, is not, it is supposed, injurious: care, however, must be taken not to carry this notion too far, particularly in the case of squitch or couch grass, or so as to suffer any of the quick growing weeds to ripen their seeds, or the luxuriant ones to become too large for being buried with the plough. As these remarks are judicious, and perfectly practical, they deserve the particular attention and consideration of the farmer, wherever the weeding and proper cleaning of his ground is concerned.

It is stated too, that in this view, if a fallow for turnips be cross-ploughed and harrowed down in the month of March, it will generally lie very well to the beginning of May; and that in general no fallow will want ploughing oftener, in such intention, than once in six weeks, if sufficient harrowings be given between the ploughings. The particular time most proper for these operations must, however, be determined not by any general rule, but by local circumstances, experience, and observation.

In cases where lands have not undergone proper improvement, or been under a bad state of management, weeds cannot be destroyed without much labour and expence. (See WEED.) But where lands are already improved, and have been for some length of time under a good system of management, the business is in part performed, and the evil much lessened; as in such cases, as well as all others, every rotation or course of cropping should render the land cleaner and freer from weeds, which will certainly be the case, where there is a proper and correct attention bestowed on the business. The means which are necessary to be used in this intention are commonly, it is said, these: complete and well-managed fallows, as above, when fallows are necessary or proper; the use of manures, which are free from the seeds or quick roots of weeds; the careful choice of such seed grain as is clean; the practice of short tillages, or that of not taking too many crops in rotation; the having recourse to attentive weeding and a spirited use of the hoe, in which view the drill husbandry doubtlessly, it is supposed, affords superior advantages to the broad-cast, in keeping land clean from weeds; but that land must be well cleaned before the drill husbandry is applicable; the plentiful use of the clean seeds of the best grasses and trefoils at the end of the tillage, in each case; the weeding of the land, when in or at grass, so as not to suffer the seeds of any noxious or injurious plants to spread themselves; and that when upon again breaking up the land, to pursue such a system or plan of cropping as will not increase or encourage weeds. But though much might be said on each of these points, it is thought unnecessary, as the intelligent farmer will readily

adopt every necessary regulation and precaution from his own observation and experience. It will, therefore, only be needful to slightly touch upon the different particulars or objects. As the subject of fallows has been already considered and explained, it is unnecessary to be further noticed in this place. In regard to fold-yard manure, it should always, it is supposed, in this intention, undergo a fermentation before it is laid upon the land, sufficient to prevent the future vegetation of any seeds that may be contained in it: but it should likewise be kept as free as possible from the seeds of weeds; and perhaps it is best laid on grass-land, applying only lime, or other manures certain of being clean, to fallows; or if dung not certainly clean from seeds be laid on fallows, it should be applied on them early enough to give time to have the seeds to vegetate and spend themselves before sowing for the crop. It is said, that every one knows the necessity of clean seed-corn to the producing of a clean crop, but sometimes neglects to apply such knowledge; and indeed clean seed-grain is not always to be procured. If weed-seeds be suspected, they should, as often as possible and practicable, be dressed out before sowing the corn. The weeding of crops is generally imperfectly performed, and is likely to continue so, it is thought, in many places, on account of the difficulty of procuring hands enough for work which is only so temporary in its nature. Thistles are generally only cut off, but they should always, it is said, by drawn up by tongs, or other tools for the purpose, and the other sorts of weeds by the hand. The hoe has yet been only of general use in turnip crops, nor is it likely to extend further, unless the drill husbandry should be more established; nor even, in its present application, can proper hands enough be always, it is said, procured at sufficiently reasonable rates. As much, however, should constantly be done in all these ways as circumstances will allow. In the laying down of land to grass, the importance of clean grass-seed is well understood; yet the seeds of docks are not unfrequently sown with clover, and those of other pernicious weed-plants with ray-grass. In all cases, the utmost attention should be paid to the sowing of clean seed of this small kind. And in the weeding of grass-land, docks and thistles are often mown, or only cut off, but they should always be rooted up; for which purpose, docking irons formed upon sufficiently good principles are mostly had recourse to. They are, it is supposed, every where well understood, consisting simply of a forked or cleft spike of iron, which is jogged within the cleft, and fixed to the end of a wooden lever: this being forced down by the hand or foot, so as to inclose the root of a dock, or large thistle, will easily bring it up, particularly after rain; but mowing them off, being done with more expedition, is often practised; and they are sometimes left undisturbed, and suffered to scatter their seeds without any effort being made to prevent it, which is very injurious, and always to be avoided as much as possible. It is stated too, that upon breaking up a turf or sward, it is understood in the writer's neighbourhood, that unless a wheat fallow or a turnip crop compose a part of the tillage, the land will be injured, and rendered fouler, and more addicted to produce weeds: this notion is, it is believed, a just one, though often deviated from in practice, for the sake of present profit, and under the delusive idea of cleaning the land again next tillage. It is, however, well ascertained, that land well cleaned by former good management will best bear this deviation; for the fewer weeds it contains at breaking up, the less will be the increase of them during the tillage or after-culture of the ground.

The writer of the Elements of Agriculture noticed

above has observed, that it is not enough to attend to weeding in the time of tillage-culture only: it is proper that grass-fields and lands should likewise be kept free of all noxious, hurtful, and unprofitable herbage. The negligence which may be seen in this respect, in many districts and places, is, it is said, shameful. Pastures and other grass-lands are sometimes so close covered with large weeds, that the pasturing animals have scarcely room to pick up a mouthful; and thus the vegetable food and other matters, which should nourish good and wholesome pasture and other grass-land herbage, is consumed by useless weeds. And speaking of different coarse and disgusting weed-plants, such as the dock, ragweed, bur, corn, and sow-thistles, and some others, it is remarked, that the two last are of the sort which extend their vivacious roots below the reach of the plough, when the land is in tillage. It is not, it is said, uncommon with those who affect to pay a little more attention than ordinary to their pastures and grass-lands, to cut down these plants in the flower. If this be done in a rainy time, or if such rain falls soon after, the water descending into the fresh cut wound of the stem, debilitates the roots, and discourages the growth of the plants for a time, though they are seldom wholly destroyed by it; but that if such critical rains do not occur, fresh leaves immediately arise to support the roots, and the cutting over has very little or no effect. They should consequently be annually pulled up by the roots as soon as possible, after the flower begins to form and shew itself, taking advantage of the first shower which happens to fall, to soften the ground and make them draw up more freely. By pursuing this practice regularly and steadily for a number of years, the deep lying perennial roots are, it is said, gradually weakened, and fall into decay. Nor is cutting down the ragweed of much avail. Some of the plants die, but many survive, and branch out more copiously the ensuing year. But this plant not being deep-rooted, is easily pulled up when in flower, if the ground be soft at the time. The bur-thistle being a biennial plant, may be killed at any time by cutting it under the first leaves. The common dock is the most troublesome plant in grass-land, especially in clayey soils, where it is always the most frequent. Every bit of its long tap-root left in the ground will continue to vegetate and grow, and at length form a new stem and plant. It should, in all cases, be fully turned out with the dock-iron, in the manner already noticed, as soon as the flowering-stem is formed; and as the plants of this kind rise at two seasons, the pasture or grass fields should be weeded twice in the summer, that no seeds may be allowed to ripen. The roots should be fully exposed to the heat and drought; for if they be in a moist place, they will continue to vegetate on the surface, as they lie and strike out side-roots into the ground. All other inesculent herbage on pastures and other sorts of grass grounds, and all weeds bearing seeds by the sides of roads, ditches, brooks, and other such places, should be cut down too, when they begin to flower, in order to prevent their increase by their seeds being dispersed over the grass fields and grounds.

The writer of the Gloucestershire Report on Agriculture, in reproaching the practice of confining the business of weeding almost solely to the tillage-lands, while the meadows and pastures are almost wholly neglected, and overrun with docks, thistles, nettles, hemlock, and many other such weed-plants, remarks, that it is supposed by the farmers, that the scythe will be early enough to cut them off: the seeds, however, are generally ripened and dispersed before mowing time; and if not, they are carried with the hay to the stall, and mixed with the dung, or into the pasture

WEEDING.

ture for fodder during the winter; in either of which cases they cannot fail, it is supposed, of increasing greatly. Besides, the mere cutting off this kind of weeds rather improves than diminishes their growth, by forcing them to throw out new shoots from the roots, and that in greater abundance than before. Thus, a thistle, which rises at first with a single stem, if cut off above the surface of the ground, spreads with several lateral branches, and covers a large space of ground. The most likely method of destroying them is to draw them up by the roots, as already seen, which may easily be done when the ground is moist, and is done by those farmers there, it is said, who are anxious for their credit, nice in their herbage, and proud of seeing their pastures rivalling the neatness of a lawn. The negligence, indeed, of a neighbour often operates as a discouragement, and it is an evil not easily to be prevented: it is, however, surprising in another instance, it is said, to observe an almost unanimous encouragement given to the multiplication of noxious weeds. In the highways they are left to grow to maturity, and their seeds are dispersed in immense quantities in every direction, and all over the country, by the wind, or by being carried by birds. Under these circumstances, it is said to be certainly of little use for one, or even all the occupiers of ground, to clear their lands of weeds, while this plentiful source of them remains unmolested. One should suppose, the writer observes, that the evident mischief resulting from this neglect would excite a general combination against these destructive enemies to the interests of agriculture: that, however, not being the case, might it not, it is asked, be convenient to incorporate with the duty of the surveyors, or overlookers of the roads, the business of cutting up, and otherwise destroying, such kinds of weeds within their districts or boundaries? Should the fact of the thousand-fold increase of such self-sown seeds be doubted or disputed, let, it is said, any one but observe a patch on a common, from which the turf or sward has been pared, how completely it will be covered with thistles in the following summer; and the arable fields adjoining are not much better, where this negligence prevails.

And the writer of the paper on the subject of weeding states, that there is another cause of the increase and propagation of weeds, which may be termed a *public* cause, and which it is not in the power of any individual to prevent; but which a slovenly, neglectful, or ill-disposed person may promote and increase, and which can only be effectually prevented by a *political* regulation, and for which, it is believed, no provision has yet been made in our political code: thus are the numbers of vigorous and luxuriant weeds which are suffered to ripen their seeds in our hedges, pastures, woods, and other lands, and the seeds of which being provided with feathery matters, are dispersed over the whole territory of the kingdom, and propagate themselves far and near, growing in whatever places they alight and settle, and producing a most abundant crop: the most common and pernicious of which are supposed to be the different sorts of sow-thistles, sow-worts, common thistles, colt's-foot, groundfels, knap-weeds, &c. For as the seeding and scattering of the seeds of all these sorts of plants is clearly a public nuisance, and as they are subject to be carried to a great distance by the above means, and to do harm to the lands of all occupiers indiscriminately, they should, it is thought, be under the controul of our political regulations. This would be the effectual means of preventing much labour and expence to the farmer and the occupier, in the weeding of different kinds of lands and crops, and at the same time go a great way in rendering the territory of the country ultimately clear of a great proportion of its most noxious and hurtful weeds.

Besides, regulations of the above kind have been applied in different countries and places to weed-plants, which are much less injurious and hurtful than these. See *WEED*, and the above paper in the fifth volume of Communications to the Board of Agriculture.

In some cases and parts of the country, the weeds in the lefts heavy tillage-lands are destroyed, by an entire and perfect summer-fallow every third year, which is an effectual but expensive method of proceeding; but on the strong loams and other heavy soils by good hoeing and hand-weeding the drilled or set crops of beans, peas, and some other kinds. On the sandy and other light loams, by well hoeing and weeding by hand the crops of peas, potatoes, turnips, and some others. As soon as the peas or tares are off the land, the ground is ploughed and well harrowed, and the root-weeds picked or raked together, and burned or otherwise disposed of, as noticed above; which is mostly repeated after the cross-ploughing and harrowing have been performed. The ground being then in a great measure free from root-weeds, the turnips are sown, and the seed-weeds that may arise destroyed by twice or oftener hand-hoeing and weeding. This sort of practice being repeated or put in execution once in three or four years, is capable of keeping light land tolerably clean and free from weeds. However, in the case of a hot dry summer, the labour and expence of raking, collecting, picking, and burning the weeds, may not unfrequently be saved, and the roots destroyed, by only harrowing them to the surface after every ploughing; and by that means exposing them well to the heat of the sun for a sufficient length of time to kill them, which is sometimes effectually done in the course of a week. Care must, however, always be taken that they are fully and completely destroyed, otherwise much mischief may be the consequence, as they are extremely tenacious of life.

In all cases, where the staple or vegetable mould of the soil is of a sufficient depth to admit of trench-ploughing, that sort of ploughing, with the assistance of heavy rolling, and other proper means, will in some circumstances completely destroy root-weeds. In some cases, it is even more effectual for that purpose, it is said, than any greater number of ploughings, and is an excellent method, where it can be accomplished without turning up a poor barren subsoil. The great utility and importance of it in cleaning garden-grounds have been already seen, and it is supposed to be equally beneficial in destroying weeds, and preserving the soil moist in the most drying weather of the summer season. See *TRENCH-Ploughing*, and *TRENCHING*. Also *RIDGING-up*.

The work of weeding in all cases should be begun sufficiently early in the spring, that the weeds may not be in too forward a state, and the business, in whatever way it is undertaken, be effectually and completely performed, without any sort of omission or neglect. In the meadows and pasture-lands it should be equally attended to as in the corn-fields, as in all situations weeds are a very great drawback upon the farmer's profit, and of vast inconvenience in many different ways.

It is presumed by the writer of the paper on weeding, that if the above proposed regulations, precautions, and methods of destroying injurious plants were generally adopted in practice, they would render the British empire as free from weeds as those of China and Japan.

It may be concluded that, on the whole, by great, unremitting, and proper attention, with some such regulations as the above, to the extermination and destruction of all sorts of useless and hurtful weeds in cultivated grounds, and from meadows and pastures, the growth of injurious and worthless plants may be prevented, and the arable crops be rendered

dered much more abundant and productive than they usually are, and those of the grass kind be provided with a better and more useful herbage for the support of live-stock of all kinds, which would greatly contribute to the farmer's profit and advantage.

WEEDING-Chisel, in *Agriculture*, an useful tool with a divided chisel point for cutting the roots of large weeds within the ground. See **WEED-Hook**.

WEEDING Dock-Spit, the tool used in extirpating weeds of the dock, thistle, and other such large kinds which are to be got up by the roots. It is a sort of crow or lever, with a claw at the bottom end of it, a little curved forward, and divided into two side parts, in somewhat the manner of the thin end of a common hammer used for drawing nails: it has an arm or tread which projects at about eight or ten inches from the lower end, for the foot to rest firmly upon in forcing it into the ground, and at a little distance above it, on the back side, a curve of iron, projecting about three inches; on the upper or top end, a handle is fixed, and fastened as in the common spade: in using it the claw seizes the root of the plant, and, by a gentle pressure of the handle end downwards, in the manner of the lever, easily and readily draws or forces it out of the ground: by means of this simple implement or contrivance, many hundreds of such weed-plants may be eradicated or drawn out in the course of a day. It has sometimes the names of weeding-spud or spade, and dock-spit or spud given it. See **WEEDING**.

WEEDING-Forceps, or Tonges, the tool of the nipper kind, which is made use of for taking up some sorts of plants in weeding corn and other crops, such as small thistles of different kinds, small docks, and various other such weeds. It seizes them by the mouth part, which is fixed upon them by means of the long handles in using it, and readily forces them up. See **THISTLE-Drawer**.

WEEDING-Fork, a strong three-pronged fork of the fork sort employed for working root-weeds in tillage-lands, and forking out the weeds of the same kind in garden-grounds; in both which cases it is a very useful and effective tool. It is sometimes made with flat prongs, and termed a spud in plantation-grounds. See **FORK**.

WEEDING-Shim, an implement which is constructed differently to suit different purposes, but that which is made with a frame somewhat like that of the common wheelbarrow, is considered the best in the county of Kent, where tools of this sort are much used in the plantation-grounds for different crops. It is a very useful and convenient tool for the purpose of tearing up weeds on summer-fallows, and in many other cases. Its cheapness too is a great recommendation of it, as it is capable of being well constructed for about two pounds. See **HARROW**, &c.

WEEDING-Spud. See **WEEDING Dock-Spit supra**.

WEEDS, in *Mining*, a term used by our English diggers to express any sort of unprofitable substance found among the ores of metals. They seem to have borrowed the phrase from the gardeners; and as every thing with them is a weed, except what they have planted, and expect to gather, so every thing is a weed with the miners, except the thing they are sinking for. See **DIGGING**.

The principal substances known in our mines under the name of weeds, are mundic or marcasite; this is of three sorts, white, yellow, and green; daze, a kind of glittering talky stone, of the telaugium kind, which endures the fire, and is of various colours and hardnesses; iron-moulds, or pyritæ; caul, which is brownish and spongy; and glister, which is a sort of talc. Phil. Trans. N° 69.

WEEDS also denote a peculiar habit, worn by the relicts of persons deceased, by way of mourning. See **MOURNING**.

WEEK, *Septimana, hebdomada*, in *Chronology*, a division of time, comprising seven days.

The origin of this division of weeks, or of computing time by sevenths, is greatly controverted. Some will have it to take its rise from the four quarters or intervals of the moon, between her changes of phases, which, being about seven days distant, gave occasion to the division. Be this as it will, the division is certainly very ancient. The Syrians, Egyptians, and most of the oriental nations, appear to have used it from all antiquity: though it did not get footing in the West till Christianity brought it in: the Romans reckoned their days not by sevenths, but by ninths; and the ancient Greeks by decads, or tenths.

Indeed, the Jews divided their time by weeks, but it was upon a different principle from the other eastern nations. God himself having appointed them to work six days, and to rest the seventh, in order to keep up the sense and remembrance of the creation; which, being effected in six days, he rested the seventh.

Some authors will even have the use of weeks, among the other eastern nations, to have proceeded from the Jews; but with little appearance of probability. It is with better reason that others suppose the use of weeks, among the heathens of the East, to be a remain of the tradition of the creation, which they had still retained with divers others.

This is the opinion of Grotius, *De Veritat. Relig. Christi*. lib. i., who likewise proves, that not only throughout the East, but even among the Greeks, Italians, Celtæ, Sclavi, and even the Romans themselves, the days were divided into weeks; and that the seventh day was in extraordinary veneration. This appears from Joseph. *adv. Apion*. II. Philo. *de Creatione*. Clem. Alexand. *Strom.* lib. v. Though Helmoldus, lib. i. cap. 84. Philostratus, lib. iii. cap. 13. Dion. lib. xxxviii. Tibullus, Lucian, Homer, Callimachus, Suetonius, Herodotus, &c. who mention the septenary division of days as very ancient, suppose it to have been derived from the Egyptians.

The *days of the week* were denominated by the Jews, from the order of their succession from the sabbath. Thus, the day next after the sabbath, they called the *first* of the sabbath; the next, the *second* of the sabbath; and so of the rest; except the sixth, which they call *parasceve*, or preparation of the sabbath.

The like method is still kept up by the Christian Arabs, Persians, Ethiopians, &c. The ancient heathens denominated the days of the week from the seven planets; which names are still generally retained among the Christians of the West. Thus the first day was called *Sun-day*, *dies solis*; the second *Moon-day*, *dies lune*, &c. a practice the more natural on Dion's principle, who says, the Egyptians took the division of the week itself from the seven planets.

In effect, the true reason of these denominations seems to be founded in astrology. For the astrologers distributing the government and direction of all the hours in the week among the seven planets, ♃ ♄ ♂ ♁ ♀ ♃ ♄, so as that the government of the first hour of the first day fell to Saturn, that of the second day to Jupiter, &c. they gave each day the name of the planet, which, according to their doctrine, presided over the first hour thereof; and that, according to the order specified above; and which is included in the following technical verse.

Post SIM SUM sequitur, pallida Luna subest.

Wherein, the capital letters SIM SUM, and L, are the initial letters of the planets. So that the order of the planets

planets in the week, bears little relation to that in which they follow in the heavens: the former being founded on an imaginary power each planet has, in its turn, on the first hour of each day.

Dion. Cassius gives another reason of the denomination, fetched from the celestial harmony. For it being observed that the harmony of the diatessaron, which consists in the ratio of 4 to 3, is of great force and effect in music; it was judged meet to proceed directly from Saturn to the Sun; because, according to the old system, there are three planets between Saturn and the Sun, and four from the Sun to the Moon.

Our ancestors the Saxons, before their conversion to the Christian faith, named the seven days of the week from the Sun and Moon and some of their deified heroes, to whom they were peculiarly consecrated, which names we received and still retain: thus Sunday was devoted to the Sun; Monday to the Moon; Tuesday, according to some, to Tuisto or Tuisco, mentioned by Tacitus; but, according to others, to Thyfa or Dyfa, the wife of Thor, and the goddess of justice; or, according to others, to Tyr; Wednesday to Woden, the god of war; Thursday to Thor, who presided over the air, and was supposed to govern the winds and clouds; this is the same with Lucan's Taranis, similar to the Welsh word for thunder; Friday to Friga or Fræa, the wife of Thor, and the goddess of peace and plenty; and Saturday to Seater, called also Orodo, to whom they prayed for protection, freedom, and concord, and for the fruits of the earth. The origin of the last appellation, however, is doubtful; as some have observed, that the name *Seater* is not mentioned by any writer before *Verftegan*. See *Verftegan's* Restitution of decayed Intelligence, p. 68. Junii Etym. Angl. and Mallet's North. Ant. vol. i. p. 91, &c.

To find the accomplishment of Daniel's prophecy of the Messiah, the destruction, rebuilding, &c. of the temple, chap. ix. ver. 24, &c. the critics generally agree to understand *weeks of years*, instead of *weeks of days*.

Accordingly, Dr. Prideaux, fixing the end of these weeks at the death of Christ, in the year of the Julian period 4746, and in the Jewish month Nisan, dates their commencement in the month Nisan, in the year of the Julian period 4256, which was the very year and month in which Ezra had his commission from Artaxerxes Longimanus, king of Persia, for his return to Jerusalem, there to restore the church and state of the Jews. And thus he finds, that from the one period to the other, there were exactly 70 weeks of years, or 490 years. Connect. vol. ii. p. 381, &c.

WEEKS, *Ember*. See EMBER.

WEEKS, *Feast of*. See PENTECOST.

WEEK, *Passion*, or the *Holy Week*, is the last week in Lent, in which the church celebrates the mystery of our Saviour's death and passion.

This is also sometimes called the *great week*. Its institution is generally referred, both by Protestants and Papists, to the times of the apostles. All the days of that week were held as fasts: no work was done on them; no justice was distributed; but the prisoners were ordinarily set at liberty, &c. even pleasures, otherwise allowed, were at this time prohibited. The osculum charitatis was now forborn: and divers mortifications practised by all sorts of people, and even the emperors themselves.

WEEK, *Rogation*. See ROGATION.

WEEK, or *Wick of a Candle*, &c. the cotton match in a candle or lamp. See CANDLE, LAMP, &c.

WEEK-Fish, in *Ichthyology*, a name given by some to a

very delicate fish, caught on the East Indian shores, and called by the Dutch there the *wit-visch*. See WIT-Fish.

WEEKLY *Markets and Fairs*, in *Agriculture*, are of considerable use and convenience to the farmer and land-owner, as affording the ready means of purchasing, providing, and furnishing them with the different articles they are continually in need of, as well as the various fairs and descensions of cattle and other live-stock, which are always wanted in such cases; as they are common in most large towns, the former once or oftener in the course of the week, and the latter in some instances in that time, and at more distant periods. They give the means, too, of readily disposing of all sorts of produce and stock of the farm kind, which is often a very great accommodation and advantage to the farmer and store-master, as is fully seen in the weekly market of Smithfield in the metropolis, as well as in many particular markets and fairs in the country, as at Liverpool, Lancaster, Garstang, and many other towns in the north; and at Uxbridge, Reading, Chelmsford, Petworth, and a variety of other towns in the south. See Owen's Book of Fairs, &c.

WEELING, ANSELM, in *Biography*, born at Bois-le-Duc in 1675, was an imitator of Godfrey Schalken and Adrian Vanderwerf; but particularly of the former; and many of his productions have been taken for pictures by that master. He died in 1749.

WEELS, in *Geography*, a river of Germany, which rises in the duchy of Oldenburg, and joining the Ochte, in the county of Delmenhorst, falls into the Wefer, 8 miles N.W. of Bremen.

WEEN. See HWEN.

WEENINX, JOHN BAPTIST, in *Biography*, an excellent artist, was born at Amsterdam in 1621, the son of John Weeninx, an artist of considerable celebrity. He lost his father when he was very young, and was placed by his mother with a bookfeller; but his taste for painting manifesting itself decidedly, he was allowed to indulge it, and was placed as a disciple with John Micker, and afterwards with Ab. Bloemart. He made a rapid progress, and drew with superior power the principal buildings in Amsterdam and its vicinity. Animals, birds, huntings, &c. he was skilled in representing, and he soon began to paint his subjects with success. He left Bloemart, and studied a short time with Moojaert; but when he was 18, he found himself sufficiently established to trust to himself, and his pictures were favourably received.

A desire to improve led him to Rome, where his talents recommended him to many of the principal personages; among others, the cardinal Pamphili gave him a pension, and honoured him with many commissions: he would fain, indeed, have retained him at Rome, but the solicitations of his family, and his natural desire of exhibiting his power among his countrymen, induced him to return to Holland, after an absence of four years. On his return, he found abundant admiration and employment, which, indeed, he very well merited, as his extraordinary facility in painting a vast variety of subjects has rarely been equalled. He painted history, portraits, landscapes, sea-ports, animals, and dead-game; but he particularly excelled in Italian sea-ports, enriched with noble architecture, and decorated with figures. There is a very beautiful specimen of his power in the gallery of Cleveland-house, which in Britton's Catalogue is numbered 243. He unfortunately died very young, in 1666, being only 39 years old.

WEENINX, JOHN, son of Baptist, mentioned above, was born at Amsterdam in 1644, and was instructed in painting by his father until he was 16 years of age, when

he had the misfortune to lose that able instructor. His talent was not of so general a nature as that of his father; but in birds, flowers, animals, and fruit, he has seldom been surpassed for the boldness, animation, and correctness of touch, or the brilliancy and clearness of colour, as well as of chiaro-oscuro. The elector John William invited him to his court, and many of his most considerable productions are at the gallery of Duffeldorf. He decorated a hunting seat of the electors, the chateau of Benberg, with a series of hunting of the boar and the stag, in which he displayed his skill and taste with brilliant effect. His smaller works are exquisitely finished, yet with great breadth, and deservedly esteemed. He died in 1719, at the age of 75.

WEEPER, in *Zoology*. See *SIMIA Capucina*.

WEeping, in *Physiology*. See LUNGS and TEARS.

WEeping-Rock, in *Agriculture*, that sort of laminated, or porous, open rock, through which water passes in a slow, gradual, weeping manner. Strata of this kind are not unfrequently very troublesome in the practice of draining. See WALL-Spring and SPRING-Draining.

WEeping-Spring, that sort of discharge of water from the internal parts of the earth which is produced in a very slow weeping manner. The draining of springs of this sort is sometimes not attended with much difficulty, while in other cases they are often very troublesome. See SPRING and SPRING-Draining.

WEER. See WEIR.

WEERAWAU, in *Geography*, a town of Hindoostan, on the borders of the desert of Cutch; 40 miles W. of Buddakano.

WEERDT, or WERDT, a town of Germany, in the bishopric of Munster, on the Old Ifsel; 40 miles W. of Munster. N. lat. $51^{\circ} 52'$. E. long. $6^{\circ} 33'$.

WEERT, or WERT, a town of France, in the department of the Lower Meuse; 10 miles W. of Ruremond. N. lat. $51^{\circ} 17'$. E. long. $5^{\circ} 43'$.

WEERT, *Nieder*, a town of France, in the department of the Lower Meuse; 10 miles S.W. of Venlo.

WEESDALE, a town of the island of Shetland; 6 miles N.W. of Lerwick.

WEESSENSTEIN, or WESSENSTEIN, a town of Saxony, in the margraviate of Meissen; 5 miles S.W. of Pirna.

WEEVER. See WEVER.

WEEVER, in *Ichthyology*, the English name for the fish called by Willughby and other authors the *draco-marinus*, or sea-dragon.

Belon says, that this name is a corruption of the French *la vive*, because this fish is capable of living long out of the water.

Mr. Pennant describes another species, under the name of the *great weever*, the *draco major*, or *araneus* of Salvan, which inhabits the sea near Scarborough. Brit. Zool. vol. iii. p. 171.

WEEVIL, in *Natural History*, the name of a small insect which does great damage in magazines of corn, by eating into the several grains, and destroying their whole substance.

This creature is somewhat bigger than a large louse, and is of the scarab or beetle kind, having two pretty, jointed, tufted horns, and a trunk or piercer, projecting from the fore part of its head: at the end of this trunk, which is very long in proportion to its body, there is a sort of forceps or sharp teeth, with which it gnaws its way into the heart of the grain, either to seek its food, or to deposit its eggs there.

By keeping these creatures alive in glass tubes, with a

few grains of wheat, their copulation and manner of generation have been discovered. The female perforates a grain of wheat, and in it deposits a single egg, or, at the utmost, two eggs; and this she does to five or six grains every day, for several days together. These eggs, which are not larger than a grain of sand, in about a week produce as odd a sort of white maggot, which wriggles its body very much about, but is very little able to move from place to place: this, in about a fortnight, turns to an aurelia, from which is produced the perfect *weevil*. This destructive creature is itself very subject to be destroyed, and when in the egg or aurelia state, it is very subject to be eaten by mites. Baker's Microf. p. 221. Leewenhoeck, tom. iv. ep. 76.

It is stated in a series of communications which contain different interesting particulars, inserted in the appendix to the Corrected Report on the Agriculture of the County of Middlesex, that J. L. Banger, esq. of the island of Madeira, has found that steaming such grain as is infested with the weevil has the effect of preserving it. In comparing the method used by another person with his, on portions of the same cargo of grain, the quantity or weight was greater in the latter; but the most essential difference was in the quality, which in the former was almost unsaleable, while in the latter, or that of steaming, it was better and sweeter than when first received. The produce of grain from the island of St. Michael it is found cannot be preserved so long a time as that which is imported from any other country, though the manner of keeping it there, which might throw some light upon the subject, is not known: of this the writer has recently obtained sufficient experience, it is said, by having ordered a part of a cargo of grain to be placed in a store which had lately been used with that island wheat; and from this cause, in a very short time, had become badly infested with the weevil. Another purchaser of a part of the same cargo, too, is, from a similar cause, a sufferer. The writer has not, however, much anxiety about it, as the grain he purchased and steamed once on the first of January, and again on the first of June, is now, (the time of writing,) in perfect preservation, and free from the weevil. The Indian corn too, that was purchased then in March last, at which time it was very full of the insect, is at present free and perfect, it is said, without a second heating. It is intended passing it again through the steam, however, it is said, as soon as the apparatus is properly fixed, when no doubt is made of its keeping through the year. In examining the particular tendency that the grain lately arrived has to the generation of the insect, the writer has imagined it in some measure to proceed from the embargo laid upon American vessels having obliged the merchants in the different sea-ports to keep their granaries so full as to have heated the grain; though he has some reason to think that the months of March and September are attended with peculiar circumstances respecting the increase of the weevil.

It is found that by the consumption of one hundred pounds weight of coals in a kitchen portable steam apparatus, three moys, or seventy-two English bushels of grain can be steamed in the common hours of work of one day.

The writer had then lately steamed a granary of sixty moys, or one thousand four hundred and forty English bushels, in about three weeks. The waste of grain, not badly infested with the weevil, is found to be one per cent. in weight in one month, and the increase so rapid, that if proper precautions be not taken, in less than six it will be rendered totally unfit for use; and that in the West Indies the writer is satisfied from his own experience, that three months will be equal, in destruction to the grain, to that

that of six months in the temperate climate in which he writes. Perhaps, it is said, no part of the globe would experience so much benefit from the use of steam as a rice country.

The writer having, by substituting copper tubes for those of tin, which were at first employed, but tinned to prevent mischief, at last succeeded in getting them sufficiently tight, proceeded better in his trials: the steamed rice remained free from dust, and it is supposed that steam may be rendered very serviceable in separating the husk from the grain in that case, as well as in barley, &c.; nay, that it may be extended to flax, and many other articles.

The attention of the writer more lately has been particularly attracted, by finding some grain that had been steamed to grow, when sown, in repeated trials; and from the very flourishing state of what is come up, and his own observations, he is led to think that the blight in wheat might be materially prevented by having it steamed before it is sown. It was afterwards discovered that the flourishing condition of the wheat sown after steaming surprised every one who saw it; and it is thought to be an object worthy of consideration.

It was found, on taking a certain quantity of wheat that had been steamed, and of such as had not, and sending them to the mill, that there was an increase of nearly five *per cent.* in the bread produced from the wheat that was steamed: but it is not certainly known if this difference would have arisen, if the latter had been dried in the sun or an oven, as sometimes practised there, but which is troublesome. The best bread made there is, it is said, from a mixture of fine American flour and island wheat; and the writer has no doubt, that if a baker was to make use of steam, he might, in the proportion of wheat in the quarter loaf, save from five to ten *per cent.*

The writer intends to try the advantages to be gained by steaming seeds to be sent to foreign countries. Biscuit, he is convinced, may be kept any length of time by it; but from its size, the operation of steaming it is considerably more difficult than grain. Wheat provided in any way, in general, it is said, gets better and more free from the weevil by steaming. See the Paper.

The weevil, too, is said to be very injurious and destructive to the wheat and Indian corn in America, so that the means of preventing it must be of great utility and consequence.

WEFERLINGEN, in *Geography*, a town of Westphalia, in the principality of Halberstadt, insulated in the duchy of Magdeburg; 25 miles N. of Halberstadt.

WEFT, a kind of web, or thing woven; as, a *weft* or trefs of hair. See WEB, HAIR, TISSUE, &c.

WEFT, or *Woof*, the cross-threads of cloth. See WEAVING.

WEGELEBEN, in *Geography*, a town of Westphalia, in the principality of Halberstadt; 5 miles N. of Quedlingburg.

WEGERSDORF, a town of Prussia, in Oberland; 3 miles S. of Salfeldt.

WEGG'S ISLAND, a small island in Hudson's Bay. N. lat. 63° 20'. W. long. 90° 25'.

WEGG'S Lake, a lake of North America. N. lat. 50° 25'. W. long. 92° 25'.

WEGGIS, a town of Switzerland, in the canton of Lucerne, and capital of a bailiwick, situated on the north side of the Lake of Lucerne; 7 miles E. of Lucerne.

WEGSTADEL, a town of Bohemia, in the circle of Leitmeritz; 10 miles S.E. of Leitmeritz.

WEGSTAD, or VEGESTAD, a town of the bishopric of Passau, insulated in Austria; 12 miles E. of Passau.

WEHAX, LILL, and STOR, two small islands on the E. side of the Gulf of Bothnia. N. lat. 60° 45'. E. long. 21° 7'.

WEHEN, a town of the principality of Nassau Saarbrück Ufingen; 10 miles N.N.W. of Mentz.

WEHLEN, or WEHLAU, or *Wehl-Städtel*, a town of Saxony; 5 miles S. of Pirna.

WEHMALAIS, a town of Sweden, in the government of Abo; 20 miles N. of Abo.

WEHNER, a town of East Friesland; 13 miles S. of Emden.

WEHR, a river of the duchy of Baden, which runs into the Rhine, 4 miles W. of Seckingen.

WEHRENDORF, a town of Westphalia, in the county of Ravensburg; 5 miles W.S.W. of Vlothow.

WEHRENSSEE, a town of the duchy of Stiria; 6 miles N. of Luttenberg.

WEHRHEIM, a town of Germany, in the principality of Nassau Dillenburg; 18 miles S.S.W. of Dillenburg.

WEIBSTADT, a town of the duchy of Baden; 28 miles E.S.E. of Mannheim. N. lat. 49° 17'. E. long. 8° 59'.

WEICHOLTZHAUSEN, a town of the duchy of Wurzburg; 6 miles N.N.E. of Schweinfurt.

WEICHSEL. See VISTULA.

WEICHSELBURG, a town of Saxony, in the lordship of Schonburg; 14 miles N.N.W. of Waldenburg.

WEICHSELBURG, or *Weixelburg*, a town of the duchy of Carniola; 28 miles W. of Landtrafs. N. lat. 46° 5'. E. long. 14° 15'.

WEICHSELMUNDE, a fort built to defend the city of Dantzic, on the Vistula. In 1734 it was taken by the Russians; 4 miles N. of Dantzic.

WEICHTERSBACH, or WECHTERBACH, a town of Germany, in the county of Ifenburg, on the Kinzig; 23 miles E. of Francfort on the Maine.

WEICKERSBERG, or WEIKERSPERG, a town of Austria; 5 miles W. of Efferding.

WEICKERSHEIM, a town of Germany, in the principality of Hohenlohe, on the Tauber; 23 miles N.N.E. of Ohringen. N. lat. 49° 30'. E. long. 9° 58'.

WEIDA, a river of Silesia, which rises on the confines of Poland, and joins the Oder, near Breslau.

WEIDELBACH, a town of the principality of Anspach; 5 miles S.W. of Feuchtwang.

WEIDEMBERG, a town of Germany, in the principality of Culmbach; 7 miles E.S.E. of Bayreuth.

WEIDEN, a town of Bavaria, in the principality of Sulzbach, on the Nab; 17 miles N.E. of Sulzbach. N. lat. 49° 40'. E. long. 12° 3'.—Also, a town of the bishopric of Bamberg; 4 miles E. of Weismain.

WEIDENBACH, a town of Germany, in the margrave of Anspach; 5 miles S.S.E. of Anspach.

WEIDENBERG, a town of Germany, in the principality of Culmbach; 7 miles E.S.E. of Bayreuth. N. lat. 49° 55'. E. long. 11° 46'.

WEIDERAU, a town of Saxony, in the lordship of Schonburg; 4 miles N.E. of Penig.

WEIERN, a town of Bavaria; 23 miles S.S.E. of Munich.

WEIF. See WAIF.

WEIGEL, ERHARD, in *Biography*, a German mathematician, was born at Weida, in Nordgau, in 1625, and educated at Wensiedel, whither his parents were obliged to remove, on account of persecution, when he was three years old; and afterwards at the Gymnasium of Halle, where he enjoyed the advantage of being instructed in mathematics by

Bartholomew Schimpfer, a celebrated astronomer. The circumstances of his parents obliging him to return to Wundfeld, he there pursued his studies under an able tutor. Afterwards, encouraged by Schimpfer, he settled at Halle, where his reputation drew to him many pupils, by whom he was enabled to remove to Leipzig for farther improvement; so that in 1653 he was invited to be professor of mathematics at Jena. By favour of William, duke of Saxony, he was appointed mathematician to the court, and chief director of buildings; and thus the latter years of his life were chiefly employed in travelling. In the progress of his years he made many improvements in globes, and other instruments for facilitating the study of astronomy. This ingenious mathematician died in 1699. For a list of his works, which were many, we refer to his article in Gen. Biog.

WEIGELIA, in *Botany*, a Japanese genus, dedicated by Thunberg to the honour of Dr. Christian Ehrenfried Weigel, professor of Chemistry in the university of Gripfswald, in Upper Saxony, who published at Berlin, in 1769, when he was only 21 years of age, a *Flora Pomerano-Rugica*; but whose fame, as a deep and learned practical botanist, chiefly rests on his *Observationes Botanicae*, published as an inaugural dissertation, under his presidency, in 1772, in quarto, with three plates. This work, from its rarity, is not so well known as it deserves to be. The author corresponded with Linnæus, and communicated specimens of his new or doubtful plants.—Thunb. Jap. 6. Nov. Gen. 5. Schreb. Gen. 113. Willd. Sp. Pl. v. 1. 836. Mart. Mill. Dict. v. 4. Juss. 421. Lamarek Illustr. t. 105.—Class and order, *Pentandria Monogynia*. Nat. Ord. uncertain. Jussieu suspects it may belong to his *Apocinea*, the *Contortæ* of Linnæus; an opinion which the insertion of the style at the base of the germen seems to favour; but the serrated leaves are a great, perhaps insuperable, objection. If we might suspect an error as to the situation of the germen, the genus would readily range itself among Jussieu's *Caprifolia*; but the second species has more the character of his *Bignonia*, and renders it probable that Thunberg is merely mistaken in his idea of the simple nature of the germen.

Gen. Ch. Cal. Perianth superior, of five awl-shaped, erect, equal leaves. Cor. of one petal, funnel-shaped; tube the length of the calyx, internally hairy: limb bell-shaped, cloven half way down into five ovate, obtuse, slightly spreading segments. Stam. Filaments five, inserted into the tube, thread-shaped, erect, nearly as long as the corolla; anthers erect, linear, obtuse, cloven at the base. Pist. Germen superior, quadrangular, abrupt, smooth; style from the base of the germen, thread-shaped, rather longer than the corolla; stigma peltate, flat. Fruit unknown. Thunberg suspected there was a solitary naked seed.

Ess. Ch. Corolla funnel-shaped. Style from the base of the germen. Stigma peltate. Calyx superior, of five leaves.

1. *W. japonica*. Sessile-leaved Weigelia. Willd. n. 1. Thunb. Jap. 90. t. 16. Tr. of Linn. Soc. v. 2. 331. (Nippon Utsûgi; Kämpf. Am. Exot. 855.)—Leaves sessile, ovato-lanceolate.—Native of hilly situations in Japan, flowering in April and May. The stem is shrubby, with opposite, round, smooth branches, slightly quadrangular when young. Leaves opposite, sessile, pointed, copiously serrated, an inch, or rather more, in length, veiny, smooth on both sides, except the veins, which are hairy; paler beneath. Flower-stalks axillary, compressed, three-flowered, longer than the leaves, with two awl-shaped bractæas at the

base of each partial stalk, and two more about half way up. Flowers about an inch long, reddish-purple. Thunberg's description, in the *Flora Japonica*, confounds both species together, and is therefore here necessarily corrected.

2. *W. coraeensis*. Large-flowered Weigelia. Thunb. Tr. of Linn. Soc. v. 2. 331. Willd. n. 2. (Korei Utsûgi; Kämpf. Amoen. Exot. 855. Ic. Select. t. 45.)—Leaves stalked, obovate.—Native of Corea, from whence Kämpfer supposes it was brought to Japan. He describes it as *shrub* with beautiful flowers, smelling like cloves, and changeable in colour, being snow-white, flesh-coloured, and red, on the same plant. His excellent drawing, among those engraved and distributed through the munificence of Sir Joseph Banks, throws more light upon this species, and indeed upon its genus, than any thing else we have met with. It appears to be a climbing or trailing *shrub*, with round branches, and opposite stalked leaves, very like those of the *Hydrangea hortensis* in size and figure, being thrice the length of the first species, and obovate with a point. Flower-stalks axillary and terminal, three-flowered, an inch and a half long, with awl-shaped bractæas. Tube of the corolla slender, above half an inch long, twice the length of the calyx; limb bell-shaped, twice the length of its tube, divided half way down into five broad, obtuse, horizontally spreading segments. Stamens projecting beyond the mouth. Anthers incumbent. Stigma large, peltate, flat. Nothing appears respecting the germen, or its situation. We do not clearly understand the second of Kämpfer's separate figures, which is perhaps an under view of the corolla.

WEIGELSDORF, in *Geography*, a town of Bohemia, in the circle of Koniggratz; 2 miles W. of Trautenaue.

WEIGELSHAUSEN, a town of the duchy of Wurzburg; 5 miles W.S.W. of Schweinfurt.

WEIGENHEIM, a town of Germany, in the lordship of Schwarzenburg; 10 miles S.S.W. of Schainfeld.

WEIGERSTORFF, a town of Austria; 6 miles S. of Wells.

WEIGH, WAY, or WEY, *Waga*, a weight of cheese, wool, &c. containing two hundred and fifty-six pounds avoirdupois. Of corn, the weigh contains forty bushels; of barley or malt, six quarters.

In some places, as Essex, the weigh of cheese is three hundred pounds. See MEASURE.

“Et decimam caesi sui de Herting, præter unam peisam, quæ pertinet ad ecclesiam de A. Mon. Angl.” where *peisa* seems to be used for a weigh.

Coke also speaks of weighs of bay-salt.

WEIGH-Beams are steel-yards for the weighing of goods upon wharfs, &c.

WEIGHER, an officer in divers cities, appointed to weigh the commodities bought and sold, in a public balance, &c. These weighers are generally obliged by oath to do justice to both parties; and to keep a register of the things they weigh.

In Amsterdam there are twelve weighers, established into a kind of office. As it was formerly allowed them to touch the strings of the balance in weighing, it was easy for them to favour either the buyer or seller, according as the one gave them more money than the other. To prevent which abuse, it was charged on them, by an ordinance of the burgomasters in 1719, not to touch the balance in any manner whatever.

WEIGHGATT, in *Geography*, a name given to the fruit called WAYGATT, (which see,) from the wind which blows through this fruit (*waikan*, to blow,) because a strong S.W. wind blows out of it. It is also called Hindelopen. See Martens's Voyage, p. 27.

WEIGHING,

WEIGHING, the act of examining a body in the balance, to find its weight.

The distillers in London weigh their vessels when full; and for a half hoghead, which is thirty-one gallons and a half, allow two hundred one quarter and eleven pounds for the cask and liquor. For a puncheon, they allow six hundred one quarter and two pounds; for a Canary pipe, eight hundred a half and seventeen pounds.

WEIGHING-Cage, in *Agriculture*, a sort of machine or contrivance which is made in somewhat the form or manner of an open box or cage, by means of which any small animal, such as a pig, sheep, calf, or any other of a similar kind, may be very easily and expeditiously weighed, and with sufficient accuracy and correctness for the purposes of the farmer, store-master, and grazier. It is constructed on the principle of the common steel-yard. It has a strong wooden frame, on which there are steel centres, in which the pivots of the lever are hung. Upon the short side of the lever is suspended a sort of coop, surrounded by strong net-work, in which the animal intended to be weighed is put and secured; the point of suspension is connected with the coop by means of two curved iron-rods, which at the same time form the head of it. A common scale, in which the weights are to be put, is hung on the longer side of the lever. See **STEEL-Yard**.

WEIGHING-Chair, a machine contrived by Sanctorius, to determine the quantity of matter carried off from the body, and that of food taken at a meal; and to warn the feeder when he had eat his quantum.

That ingenious author, having observed, with many others, that a great part of our disorders arises from the excess in the quantity of our foods, more than in the quality thereof; as also how much a fixed portion, once well adjusted, would, if kept to regularly, contribute to health; bethought himself of an expedient to that purpose. The result was the weighing-chair: which was a chair fixed at one arm of a sort of balance, wherein a person being seated at meat, as soon as he had ate his allowance, the increase of weight made his seat preponderate: so that, descending to the ground, he left his table, victuals, and all, out of reach.

WEIGHING-House, a building furnished with a dock, and conveniences for gauging or ascertaining the tonnage of boats that are to be used on a canal.

WEIGHING-Machine for Turnpike Roads, in *Mechanics*, a machine for weighing heavy bodies, and particularly wheel-carriages. This is commonly done in order to ascertain if a carriage is within the weight allowed by law to be carried by such carriage on the turnpike-roads; a weighing-machine, or weigh-bridge, being fixed at every turnpike-gate. See **TURNPIKE**.

Formerly immense machines were used for this purpose: the machine was erected in an open building, beneath which the road passed, so that a cart, waggon, or other carriage, could be drawn under it; strong chains were then passed beneath the body of the carriage, to attach it to the extremity of an immense steel-yard. The fulcrum of the steel-yard was suspended by a lever, or by pulleys and crane-work, from the top of the building; and when the carriage was properly secured, the steel-yard was hoisted up by the crane-work, so as to suspend the waggon, and it could then be weighed by applying the sliding-weight of the steel-yard to different parts of the divided bar. Several curious machines of this kind are described by Leopold, in his *Theatrum Staticum*, 1724.

This method was tedious and dangerous; but when turnpike-roads became more common, a very superior machine was introduced, and we now find one at almost every

turnpike-gate. It is called a weigh-bridge, because the carriage is drawn upon a wooden platform or bridge, which is placed over a pit, made in the line of the road, to contain the machinery. The pit is walled within side, and the platform is exactly fitted to the walls of the pit; but as it does not touch the walls, it is at liberty to move freely up and down. The platform is supported by levers, placed beneath it, and is exactly level with the surface of the road, so that the carriage is easily drawn on to it. This is done without any difficulty or loss of time, because the platform is in the direct line of the road, and the carriage is only required to stop for a minute whilst its wheels stand fairly upon the platform, and the horses stand upon the solid ground beyond the platform. A few small weights put into a scale, like that of a common balance, determine the weight of the carriage and its load. If the weight of the carriage is previously known, the weight of the load may be found, by deducting the weight of the carriage from the total.

This weigh-bridge is placed at the side of a small house, which usually serves as a lodgement for the gate-keeper, and the scale is situated within the house. The platform is supported by two double levers contained in the pit; the ends of these levers are borne up by a long horizontal lever, which passes through one of the side-walls of the pit, and enters into the house: from the end of this lever, a small iron rod is carried up to one end of a common scale-beam or balance, from the other end of which the scale is suspended. All the levers are of the nature of steel-yards, that is, the weight or load of the bridge is applied upon the levers which support it, at points very near to their respective fulcrums, or centres of motion; whilst the ends of these levers are supported, at a very considerable distance from their fulcrums, by the long lever, and they bear upon this lever at a point very near to its fulcrum; but the counterbalancing force, that is, the effort of the weights in the scale, is applied to the extreme end of the long lever, very far distant from the fulcrum. For this reason, a small weight, as one pound for instance, placed in the scale, will bear up a large weight, for instance, 60 pounds, or one hundred weight placed upon the platform, according as the machine is constructed. This has an advantage, besides the convenience of small weights, *viz.* that the platform with the carriage does not sink down any perceptible quantity during the action of weighing; for when the weight in the scale is brought to equilibrium with the load, any motion or space which the small weight passes through, when the scale-beam vibrates, must be to the space which the platform and carriage pass through at the same instant, in the ratio of the load to the weight. Sometimes, instead of using a scale-board and detached weights, a long steel-yard is employed, with a weight to slide along upon it to different distances from the centre, until it will counterbalance the load on the platform; in that case, the lever is graduated to shew the weight upon the platform.

Salmon's Patent Weighing Machine.—This is very generally used in the vicinity of London; it points out the weight on a dial.

Plate II., Engines, contains figures of a weighing machine of the best kind. *Fig. 1.* is a horizontal plan of the levers contained in the pit, the platform being taken off to expose them. The under side of the platform is shewn at *fig. 2.* and *fig. 3.* is a vertical section of the whole machine.

E E (*fig. 3.*) is the platform; its upper surface is exactly level with the ground, and the edge of the planking of the platform is fitted into a border or frame which surmounts the side walls of the pit, leaving a small crevice all round its edges, so that the platform does not touch the fixed frame,

WEIGHING-MACHINE.

although it is very near to it. The platform is composed of a strong frame of wood (as shewn in *fig. 2.*), and the upper side is covered with wood planking. It is likewise defended from wear, by iron-bars and large-headed nails, which are fastened on the upper side. Near each of the four angles of the platform a piece of iron is fixed, as shewn by *b*; and it is on these four points that the platform is borne. When the platform is put in its place, these pieces of iron apply to the pins *bb* (*fig. 1.*), which are fixed in four strong iron levers, marked *A A*, *B B*. Each of these levers is supported at the extreme end *c*, on a fulcrum or centre-pin resting on a metal support, as shewn in *fig. 4*, which is borne by a piece of timber *oo*, worked into the walls of the pit at the angle. At the opposite ends the levers *A A* are brought together, and *B B* the same, so that all four meet in two points *aa*, and by means of links, shewn in *fig. 5*, are all connected with a long lever *CC*. This rests on a support or fulcrum *D*, borne by a pillar erected from the bottom of the pit. The end of the lever at *I* is received between two uprights to guide it, but do not any way confine its motion. In the common machine, it is from the extreme end of the lever *C D* that the iron rod before mentioned is carried up to the scale-beam, or steel-yard, as before described; but the patent machine in the figure is differently constructed in that part.

The fixed centres *c*, of the levers *A A* and *B B*, are at the ends of those levers, and the points *bb*, on which the platform bears, are very near to the centre *c*; but the distance of the points *a* from *c* is nine times as great as from *c* to *b*, consequently a force of one pound applied to lift up the levers at the point *a* would balance nine pounds laid upon the platform. In like manner the distance from the point *a* to the fulcrum *D* is only one-seventh part of the distance from the fulcrum to the end of the lever *C*; hence, one pound applied to lift up the end of the lever *C* would raise seven pounds applied at the point *a*, and seven pounds applied at *a* would balance sixty-three pounds placed on the platform. To weigh with a machine of this kind, if we use a scale and balance connected with the end of the long lever, we must use weights which are only one sixty-third part of the marks which they bear.

Mr. Salmon's machine operates in a much more perfect manner, by the help of a self-adjusting balance-wheel, which will weigh every different body, without employing any loose weights; and it shews the weight by means of an index and dial, like that of a clock. To effect this, another lever or steel-yard *FG* is applied, whereof *F* is the fulcrum, and *f* the point from which a link *C* descends to the end of the long lever *C D*. At the extreme end *G*, a strap is attached to ascend to the balance-wheel *ii*.

Now, as the distance *Ff* is only one-tenth of the distance *FG*, one pound applied to lift up the end *G* would raise ten pounds at *f*, or $10 \times 63 = 630$ pounds placed on the platform.

To draw the end *G* of the lever upwards, a thin leather strap *g* is attached to it, and the upper end of this is coiled round a small roller *b*, which is fixed upon an horizontal axis, as is shewn on a larger scale in *fig. 7*, where the axis is marked *bb*. This is reduced to small pivots at the extremities, which are borne by friction-wheels *aa*, to render its motion as free as possible. On the same axis *b* is fixed a wheel *ii*, (see also *fig. 6.*), and against the arms of this wheel a spiral ledge is fixed, with a sufficient projection to admit a fine silk line to wind upon the spiral, when the wheel is turned round. A weight *k*, which is suspended to the line, forms the counterbalance to the load placed upon the weigh-bridge (see *fig. 3.*), and the weight of the load is determined

by the distance which the roller and wheel *i* are turned round. This distance is shewn by an index *c* fixed on the extreme end of the axis *b*, and pointing to different divisions engraved round a dial, as shewn in *fig. 6*.

This single weight *k* can counterbalance all the different weights which may be placed on the platform, because the line by which the weight *k* is suspended, when it winds upon the circumference of the spiral, continually applies itself at a different distance from the centre of the axis, so as to operate with greater force. Hence, when any weight is placed upon the platform *E*, it presses down the levers *A A* and *B B*; these depress the long lever *C D*, and this again actuates the lever *F G*, and draws down the strap *g*, which unwinds from the roller on the axis *bb*, so as to turn it round, together with the wheel and spiral. The weight *k* winds upon the spiral, but the suspending line soon arrives at that part of the spiral where its radius is sufficiently increased, to enable the weight *k* to counterbalance the load upon the platform; the balance-wheel being then come to an equilibrium, will move no farther, and the index points out upon the dial the weight of the load upon the platform.

The spiral originates in the central part, at a circle which is of the same diameter as the roller, upon which the strap *g*, *fig. 3.* winds; and the weight *k* must be equal to the six-hundred-and-thirtieth part of the weight of the platform and levers *A A*, *B B*, when there is no weight upon it. When the weight *k* hangs from this commencement of the spiral, the index *c* stands at zero, as shewn in *fig. 6*. The spiral is so made, that to turn it round sixty degrees will require one ton weight to be laid on the platform, and every additional ton will turn the wheel and index round another sixty degrees, so that the machine will bear six tons before the index makes a complete revolution. Each space of sixty degrees is divided into twenty parts, which represent hundred weights; and each one is subdivided into halves or quarters, which divisions are very apparent on a large dial.

In constructing a machine of this kind, every attention must be paid to accuracy in the centres of motion of the different levers; all these points should be made of steel, and hardened. The form of the centres should be that of a sharp edge, like a blunt knife, with the edge resting on a surface of hard steel, made rather concave, (see *fig. 4.*) Centres, or bearing points of this kind, made sharp, will move with very little friction; and if the steel is good, and perfectly hard, the edges will not become blunt in many years' use. In all cases, the bearing-pins with the sharp edges must be fixed in the levers; because if the levers were made with plain surfaces, and to have sharp pins to bear upon them, there would be no certainty as to the effective lengths of the different levers, and they would vary in their power whenever the sharp edge changed its place upon the supporting surface.

The four principal levers, *A A*, *B B*, are made double, or with open loops at the ends, as shewn in *figs. 1* and *4*; two steel pins are put through the double part, one of them marked *c*, being made with a sharp edge at the lower side, but the other, *b*, is sharpened on the upper side. The former bears upon a fixed support faced with hard steel, and the other receives the metal stems, *b*, *fig. 2.* which are fixed to the under side of the platform. The two levers, *A A*, are joined together at the point *a*; and the two levers, *B B*, are also joined in a similar manner. Each pair of levers are connected by a cross-bar, as shewn in *fig. 1*, so as to make two triangles.

The ends *p* or *s*, *fig. 5.* of the compound levers *A A* or *B B*, where they join together, have a screw fitted through them, as shewn in *fig. 5*; the ends of these screws are made

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of steel, and sharp-pointed, in order to rest in a cup or socket, *r*, of steel, formed in the lower part of a loop or link *L*. The upper end of the loop is suspended upon a sharp-edged pin fixed in the lever *C D*, *fig. 1*, which levers are marked *K* and *H* in *fig. 5*. The link belonging to the lever *A A* is suspended on one end of this pin, and the other loop upon the other end of the same pin. The lever *G* is made just the same as a common steel-yard.

The spiral, *fig. 6*, must be made very correctly in brass, and the line which winds upon it should be very flexible, and of equal thickness. After every care has been taken to make all parts of the machine very accurately, they must be put together; and known weights being laid upon the platform, the divisions on the dial should be laid down from the positions of the index. If the dial is thus divided by actual experiment, the machine will weigh very accurately; but its sensibility will depend upon the sharpness of the centres of the levers, and the hardness of the steel. When it is in good order, the addition of a quarter of a hundred weight to three or four tons, on the weigh-bridge, ought to produce a motion of the index. In an average state of the machine, it may be depended upon to within half a hundred weight.

Mr. Salmon had a patent for this machine in 1796, but his invention is confined to the balance-wheel and spiral, as shown in *figs. 6* and *7*. These parts, separated from the great machine, make a very accurate and complete weighing machine by themselves, when inclosed in a box; a common scale, to contain the goods which are to be weighed, being suspended from the lower end of the strap which winds round the roller.

The introduction of these index weighing-machines for turnpike-roads is of great utility, to diminish those incessant disputes between the gate-keeper and the carriers respecting the weight of their loads. In the common weighing-machines, the weights, being loose and of an arbitrary weight, may be changed or diminished by the gate-keeper to make the loads appear greater; and the carrier has no means of detecting this fraud, except by unloading and weighing his cargo in small quantities, which is scarcely practicable; neither can he be assured of the manner of weighing, even if the weights are just. Another source of uncertainty is, whether the machine be in exact balance when there is no load on the platform; for as the wood imbibes wet and becomes dirty, it makes considerable variations in the balance of the machine. To put the machine in equilibrio, a heavy weight is hung on the end of the lever *C D*, *fig. 3*, and can be placed nearer to or farther from the centre. This should always be adjusted, but is frequently neglected, and is difficult of detection.

With the index-machine all these difficulties are avoided: it is constructed by a maker whose character is at stake, and when once truly made will continue in the same state, if the whole is locked up, so that the gate-keeper cannot have access to the index. The only defect arising from age and wear is, that the index becomes less sensible, and moves slightly and by starts. This the carrier can try at any time by pressing his foot upon the platform; and he can always tell if the index returns to zero when the load is removed; and if it does not, he can see how much the machine is out of balance.

The law respecting weighing carriages is an inducement to fraud in the gate-keepers; a certain weight is allowed by act of parliament to be carried by each description of carriage, which weight is regulated according to the width of the carriage-wheels, the number of horses, and the season of the year, whether winter or summer.

If the load does not exceed the allowed weight, a certain toll is charged for the carriage; but for all excesses of weight, a very heavy toll is charged on each hundred-weight as a penalty, the amount of which is increased in proportion to the quantity of over-weight. (See TURNPIKE.) It is a valuable prize for a gate-keeper to find a carriage overloaded.

WEIGHING-Machines for small Weights. These are of different constructions, according to the use for which they are intended.

In some the weight of any body is determined by putting loose weights into an opposite scale, and these weights may be either equal weights to those which they are to denote, as in the case of a balance with equal arms, or the weights may be smaller and applied to the longer arm of an unequal balance, as in the steel-yard. The former is by far the most accurate, and from the facility of proving its accuracy by placing the weights in either of the scales, it has become the legal mode of weighing. Steel-yards are accurate if carefully used, but afford many opportunities of fraud in the hands of dishonest persons.

Mr. Medhurst's patent weighing-machine is very useful in shops and warehouses, being more convenient than the common balance and scales, and having the same property of equal arms to the lever. The scale-boards, instead of being suspended from the arms of the balance, are securely poised between the arms of a double balance-beam, and are placed at such a height as is most convenient to receive the goods which are to be weighed. The weights are to be put into the opposite scale, but can be put in either; and the load on the opposite one, if there is any doubt of the accuracy of the balance.

When more considerable weights are to be weighed, equal weights are so inconvenient, that small machines, such as are used for carriages, are to be preferred for convenience, as they require only small weights in the scale.

There is another kind of weighing-machines which requires no loose weights, but shews the weight by a pointer or index upon a divided arch, or on a dial-plate.

The index and balance-wheel of Mr. Salmon's machine, when detached, make a very complete weighing instrument of this kind, as before described.

Other index machines act with a pendulum: thus, the scale to receive the goods is suspended from a lever, to which a pendulous arm is attached with a heavy weight at the extremity to form a pendulum. The application of any weight in the scale tends to remove the pendulum from its vertical position; and it is a property of a pendulum to increase in its effort to return to the perpendicular, in proportion to the distance which it is removed from it. The quantity of deviation from the perpendicular is indicated by an index or pointer to the divisions on an arch, and these divisions are numbered to denote the weight. The machine used for weighing hanks of cotton is of this kind, and apothecaries sometimes use a similar instrument.

Many of the index machines are made with springs, which are bent by the application of the weight; and the degree of their flexure, as determined by some indexes, is an indication of the weight applied. Several machines of this kind are described in our article DYNAMOMETER; and although they are rather differently constructed, to fit them for measuring the strength of horses, &c. all of them may be converted to weighing-machines, by applying a proper suspending hook, with a scale to receive the matter to be weighed.

A curious machine of this kind was made many years ago by M. Hanin of Paris, and presented to the Society of Arts. The weight is determined by the degree to which a femi-

a semicircular steel spring will be bent, when the weight is applied to force the ends of the spring to recede from each other. The quantity is shewn by an index, which turns round over a circular dial-plate, like a clock-hand. The principal curiosity of this machine is, that the dial contains thirteen concentric circles, each divided to shew the weight in the denominations of different countries; *viz.* on the two external circles are divisions to shew troy and avoirdupois weight in pounds; within this is a circle to shew the corresponding number of Paris livres; next Portuguese arrobas, and Spanish arrobas; then Dutch, Swedish, Danish, and German pounds; so that the instrument becomes an universal table for the ratios of these different weights.

WEIGHING-Machine, in *Agriculture and Rural Economy*, a sort of machine or contrivance made use of for the purpose of weighing neat cattle and some other kinds of animals alive, as well as different other uses. It is a machine which is perfectly simple and easy in its manner of construction. It has a beam of the steel-yard kind, at the top of which is a pin, on which the suspension of the beam is made. There is a counterpoise which is moveable along the beam by means of a sliding socket, on which is raised an iron arm, supporting a wooden box or scale to receive the counterbalancing weights in the operation of weighing. There are different levers, which are hung on a projecting pin of the beam by one end, the other resting on an iron support. There is a lid or platform, on which is placed the subject to be weighed; to the under side of this, at each corner, are attached blocks, from which proceed iron pieces, similar in form to the supporting piece, but reversed in position: by means of these four pieces the lid or platform stands with its whole weight entirely on the lever; other pieces applying themselves to the levers at a small distance nearer to the centre of the machine than to the supporting piece.

In the operation of weighing, the subject to be weighed being placed on the lid or platform, pressed by the different pieces on the levers, which by their suspension on the beam determine it from its even position by a quantity proportioned to the weight of the subject, which is expressed by the counterbalancing weights required to be placed in the box or scale. See **STEEL-YARD**.

A machine of this nature is of vast utility and importance in the different systems of grazing, feeding, and fattening various sorts of live-stock and domestic animals, especially where they are carried on to any considerable extent, not only in ascertaining and marking the progress which is made by the different animals, and in shewing how they pay for the use of any particular kind of food, or what power and property it may have in promoting the fattening process, but in many other ways.

Weighing-machines, constructed upon the same plan as those used on the public roads, are applicable, too, in the above cases, and many others of the rural kind, being ready and convenient for such uses.

WEIGHING of the Air. See **WEIGHT of Air**.

WEIGHING Anchor, in *Sea Language*. See **ANCHOR**.

WEIGHT, in *Physics*, a quality in bodies by which they tend towards the centre of the earth, or in a line perpendicular to its surface. Or, weight may be defined, more generally, a property inherent in all bodies, by which they tend to some common point, called the centre of gravity; and that with a velocity in proportion as they are more or less dense, or as the medium through which they pass is more or less rare.

Weight and gravity are generally considered as one and the same thing. Some philosophers, however, distinguish gravity as the quality inherent in the body, and weight as

the same quality exerting itself according to its natural tendency. See **GRAVITY**, **GRAVITATION**, and **DENSITY**.

Sir Isaac Newton demonstrates, 1st, That the weights of all bodies at equal distances from the centre of the earth, are directly proportional to the quantity of matter that each contains: whence it follows, that the weights of bodies have no dependence on their shapes or textures; and that all spaces are not equally full of matter.

2^{dly}, On different parts of the earth's surface, the weight of the same body is different, owing to the spheroidal figure of the earth, which causes the body on the surface to be nearer the centre in going from the equator toward the poles; and the increase in the weight is nearly in proportion to the versed sine of double the latitude; or, which is the same thing, to the square of the right sine of the latitude; the weight at the equator to that at the pole being as 229 to 230; or, the whole increase of weight from the equator to the pole, is the 229th part of the former.

3^{dly}, That the weights of the same body at different distances above the earth, are inversely as the squares of the distances from the centre, so that a body at the distance of the moon, which is sixty semi-diameters from the earth's centre, would weigh only the 3600th part of what it weighs at the earth's surface.

4^{thly}, That at different distances within the earth or below the surface, the weights of the same body are directly as the distances from the earth's centre: so that, at half way toward the centre, a body would weigh but half as much, and at the very centre it would have no weight at all.

5^{thly}, A body immersed in a fluid, which is specifically lighter than itself, loses so much of its weight, as is equal to the weight of a quantity of the fluid of the same bulk with itself. Hence, a body loses more of its weight in a heavier fluid than in a lighter one, and therefore it weighs more in a lighter fluid than in a heavier one.

The foregoing principles laid down by Newton are universally admitted as correct, with the exception of the proportional weight of bodies on different parts of the earth's surface; for it is important to observe, that he founded his calculation of the earth's ellipticity on the hypothesis of its being homogeneous, which is not the case; and hence he makes the equatorial diameter greater than the polar axis, as 230 to 229. But from the numerous experiments since made on the pendulum in different parts of the world, the ellipticity is found to be not so great.

By the investigations on this subject by the marquis de Laplace, (*Mecanique Celeste*, vol. ii.) the ellipticity is found to be $\frac{1}{230}$; and the calculations and experiments of other astronomers concur nearly in this result, making it on an average about $\frac{1}{230}$. In our article **STANDARD**, we have given tables of those determinations, and likewise of the principal experiments made on the pendulum in different latitudes; and we shall here add some further investigations and new calculations, as essentially connected with our subject **WEIGHT**, and of peculiar interest at the present time.

The chevalier Delambre, in his "Astronomie," vol. iii. p. 585, gives the following simple and elegant exposition of the pendulum, with other useful formulæ for finding the earth's ellipticity, &c.

Let h be the height of the place of observation above the level of the sea; R , the radius of the earth; then the length of the pendulum is to be multiplied by

$$\left(\frac{R+h}{R}\right)^2 = \left(1 + \frac{2Rb + b^2}{R^2}\right) = 1 + \frac{2b}{R}.$$

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Let L be the length of the pendulum at the equator; for another latitude, it will be $L + a \sin.^2 H$, so that a is the excess of the polar pendulum above the equatorial pendulum, H being the latitude of the place.

Let m and n be the two pendulums observed in two very different latitudes.

$$\begin{aligned} m &= L + a \sin.^2 H, \\ n &= L + a \sin.^2 H', \end{aligned}$$

$$m - n = a (\sin.^2 H - \sin.^2 H') = a \sin. (H - H') \sin.$$

$$(H + H') : \text{hence } a = \frac{m - n}{\sin. (H - H') \sin. (H + H')}$$

If there be a greater number of similar equations, put in each the numerical value of $\sin.^2 H$, and determine the two constant quantities, L and a , by the sum of the observations, employing, if you think proper, the method of the smaller squares.

Now the ellipticity is proved to be $0.00865 - \frac{a}{L}$. We

have then a value of the ellipticity, which may be compared with that of the degrees. It was in this manner that M.

Mathieu found the ellipticity to be $\frac{1}{298.2}$, by the six ac-

tual measurements of the pendulum made on the meridian from Dunkirk to Formentera. So far Delambre.

From the above equations and formulæ it is manifest, that if L , the length of the equatorial pendulum, and a , the difference between it and the polar pendulum, be known, all other questions connected with the subject may be accurately determined; and hence it is, that the important problem of

measuring the pendulum has long engaged, and still continues to command the attention of the first astronomers in Europe.

Laplace, in the *Mecanique Celeste*, gives the following values of L and a ; viz. $0^m.990631631 + 0^m.005637 \sin.^2$ latitude, from which formula the lengths of the pendulum may be computed in all latitudes; but the same learned author has recently published another formula in the *Connoissance des Temps* (1820, page 442), which is thus given.

“Mathieu, by a new discussion of all the observations of the pendulum, in using the results of Borda’s experiments reduced to the level of the sea, finds the following expression of the length of the pendulum,

$$0^m.990787 + 0^m.0053982 \sin.^2 \text{ latitude.}$$

“In this expression I have diminished by the two-thousandth of a millimetre the result of Borda upon this length, for the correction of the radius of the cylinder, which formed the knife edge; a radius which I value at eight thousandths of a millimetre.

“The experiments now about to be made with particular care, in the two hemispheres, will shed new light on the coefficient of the square of the sine of the latitude, or on the variation of weight on the surface of the earth.”

From the above formula we have computed the following table, and have found the earth’s ellipticity to be $\frac{1}{298}$. By this also the increase of the weight of a body from the equator to the poles is $\frac{1}{298}$ of the whole, whereas that deduced from the *Mecanique Celeste* is $\frac{1}{278}$, which proportion has been adopted by Poisson, Biot, and other writers on the subject.

TABLE shewing the comparative Weight of Bodies on different Parts of the Earth’s Surface, with the proportional Length of the Seconds Pendulum, and also its daily Number of Vibrations in each Latitude: supposing it correct at the Greenwich Observatory, that is vibrating 86400 Seconds in 24 Hours.

	Degrees of Latitude.			Weight of 100lb. in different Latitudes.	Length of the Pendulum.		Number of Vibrations in each Latitude.
					Metres.	English Inches.	
	0°	0'	0''	100.0000	0.990787	39.0083	86256.3
	5	0	0	100.0042	0.990828	39.0090	86258.1
	10	0	0	100.0165	0.990950	39.0147	86263.4
	15	0	0	100.0366	0.991149	39.0226	86272.0
	20	0	0	100.0637	0.991418	39.0331	86284.0
	25	0	0	100.0973	0.991751	39.0462	86298.3
	30	0	0	100.1362	0.992136	39.0614	86315.0
	35	0	0	100.1793	0.992563	39.0782	86333.6
	40	0	0	100.2251	0.993017	39.0961	86353.3
	45	0	0	100.2724	0.993486	39.1145	86373.7
Paris observatory	48	50	14	100.3088	0.993846	39.1287	86389.4
	50	0	0	100.3198	0.993955	39.1330	86394.1
Greenwich observatory	51	28	40	100.3335	0.994091	39.1383	86400.0
London, St. Paul’s	51	30	49	100.3338	0.994094	39.1385	86400.2
	55	0	0	100.3656	0.994409	39.1509	86413.8
	60	0	0	100.4087	0.994836	39.1677	86432.4
	65	0	0	100.4476	0.995221	39.1829	86449.1
	70	0	0	100.4812	0.995554	39.1960	86463.5
	75	0	0	100.5083	0.995823	39.2065	86475.2
	80	0	0	100.5284	0.996022	39.2144	86483.9
	85	0	0	100.5407	0.996144	39.2192	86489.2
	90	0	0	100.5449	0.996185	39.2208	86491.0

WEIGHT.

In computing the foregoing table we have, as on former occasions in this work, reckoned the French metre at 39.371 English inches, and the correctness of this measure is of the greatest importance to science. It was that originally determined by M. Picquet, in the National Institute, by comparing the platina metre with the brass yard made by Mr. Troughton, which was agreed upon by the Royal Society of London, as the best medium among our different standards, and the most accurate in its divisions. In making the necessary deductions for the effects of temperature on the different metals, Borda's tables of expansion were used; but from other tables and standards different lengths of the metre have been determined; particularly by Dr. Maskelyne, who made it 39.370226, and lately by Capt. Kater, who comes still nearer to Picquet, making it 39.37071. But unless such measurements are made from the same standard yard, and with the same tables of expansion, perfect agreement cannot be expected; and then it will be necessary to determine the important question, whether such tables and standards are quite correct? In short, an approximation to perfect accuracy is as much as can be hoped for. It is, however, satisfactory to observe, that the difference between the determinations of M. Picquet and Capt. Kater is scarcely discernible, even in the most delicate operations of an observatory, as it does not amount, when applied in measuring the pendulum, to more than one-third of a second in twenty-four hours. But for all general purposes the difference is wholly imperceptible.

This near agreement, therefore, confirms the propriety of our continuing Picquet's measure, which is sanctioned by general usage both in England and France, and has the additional advantage of numerical simplicity, which, for commercial purposes, is no slight recommendation.

Before we enter upon the subject of commercial weight, some general view ought to be given of the operations now about to take place on the pendulum in the two hemispheres, as alluded to in our quotation from Laplace.

The experiments intended by the French, in a voyage of discovery to the southern hemisphere, are to be made with pendulums of an extremely simple construction, the astronomical rates of which are previously ascertained at the Paris observatory. In these pendulums no maintaining power is applied, nor any compensation for temperature. The thermometer, therefore, and the magnitude of the arc of vibration, must be continually observed, and the necessary corrections applied, as in the experiment of Borda explained in Delambre's *Astronomie*, vol. iii. p. 579. Pendulums of a similar construction were employed by the French astronomers, M. Biot and M. Arago, at the royal observatory of Greenwich, and in other parts of Great Britain during the last year (1817); but the result of their experiments has not yet reached us.

A very correct and beautiful apparatus has lately been erected at our royal observatory, for the purpose of measuring the length of the pendulum; and also with a view of determining, with extreme exactness, the difference of the force of gravity at Greenwich and Paris, or, in other words, the comparative weight of bodies in these two latitudes.

This apparatus does not very essentially differ from that of Borda, except that a cylindrical rod of a given length is assumed as a standard, and the difference between this cylinder and the whole vibrating system is determined by a micrometer motion given to the steel table. In the French

apparatus the steel table remains fixed, and the measuring-rod is lengthened by means of a screw, till the lower surface comes in contact with the plane of the table.

We have likewise observed, that in Mr. Pond's apparatus, the pendulum of the clock is, by an ingenious contrivance, brought almost into contact with the experimental pendulum, by which the coincidences can be distinctly observed with a high optical power.

In the expedition which has been lately sent by the British government to explore the arctic regions, experiments are to be made for similar purposes, but with different apparatus. Two famous clocks, by Shelton, which were used by captain Cook, are sent. Each is furnished with a new brass pendulum of an entire piece, which can only vary in length by change of temperature, and this is to be allowed for from constant observation of the thermometer. The rates of the clocks in London have been accurately determined; and if the same can be ascertained at or near the pole, the result will be very important.

In concluding our view of the philosophy of weight, its varieties on the surfaces of the planets should be noticed; which are determined on the same principles as on the surface of the earth. See *PLANET*, and *SYSTEM*.

The weight of bodies on the surface of the sun is computed by Laplace to be about twenty-five times greater than on that of the earth; without, however, allowing for the diminution of gravity by centrifugal force, which he calculates to be about $\frac{1}{3}$. See *CENTRIFUGAL Force*.

WEIGHT, in *Commerce*, denotes the quantity of any commodity or substance, which is determined by being placed in a scale against some known standard or weight. The art of weighing is therefore of the utmost importance, as it furnishes the best practical means of ascertaining the quantity of matter in any given body, and thence the value of most of the necessaries of life.

Weights are generally made of stone, iron, lead, brass, or mixed metal; and they are mostly stamped by proper authorities, denoting that they have been sized or compared with some known or legal standard. See *STANDARD*, and also *MEASURE*.

The weights of all nations differ from each other, and frequently in the same country a great diversity prevails. The common denomination is the pound, of which there are mostly two sorts, one for weighing the precious metals, and the other for common articles; such are the troy and avoirdupois weights in England. The former is generally divided into twelve ounces, and the latter into sixteen. But their division and multiples, as well as relative proportions, are extremely various. We shall consider them here under two distinct heads, *viz.* *Ancient Weights*, and *Modern Weights*.

Ancient Weights.—From the great importance of weights and measures, their adjustments must have been coeval with the first regulations of civil society; and hence their origin is too remote to be traced by any authentic history. The only ancient weights that are known with any degree of certainty are those of the Jews, Greeks, and Romans.

The ancient Jews, having no stamped coin, weighed all their gold and silver in the following simple manner, dividing their talent into 50 maneh, and their maneh into 60 shekels.

WEIGHT.

TABLE I.—Jewish Weights reduced to English Troy Weight (from Arbuthnot).

Shekel										lb.	oz.	pwt.	gr.
										0	0	9	2 $\frac{2}{7}$
60	Maneh									2	3	6	10 $\frac{2}{7}$
3000	50	Talent								113	10	1	10 $\frac{2}{7}$

Note.—In reckoning money, 50 shekels made a maneh; but in weight, 60 shekels.

TABLE II.—Grecian and Roman Weights reduced to English Troy Weight (from Arbuthnot).

										lb.	oz.	pwt.	gr.
Lentes										0	0	0	0 $\frac{9}{17\frac{1}{2}}$
4	Siliquæ									0	0	0	3 $\frac{1}{8}$
12	3	Obolus								0	0	0	9 $\frac{3}{8}$
24	6	2	Scriptulum							0	0	0	18 $\frac{3}{4}$
72	18	6	3	Drachma						0	0	2	6 $\frac{3}{4}$
96	24	8	4	1 $\frac{1}{2}$	Sextula					0	0	3	0 $\frac{6}{7}$
144	36	12	6	2	1 $\frac{1}{7}$	Sicilius				0	0	4	13 $\frac{2}{7}$
192	48	16	8	2 $\frac{2}{3}$	2	1 $\frac{1}{3}$	Duella			0	0	6	1 $\frac{1}{7}$
576	144	48	24	8	6	4	3	Uncia		0	0	18	5 $\frac{1}{7}$
6912	1728	576	288	96	72	48	36	12	Libra	0	10	18	13 $\frac{1}{7}$

For the subdivisions of the Roman as, libra, or pound, see As.

TABLE III.—Ancient Roman Weights reduced to English Troy Weight (from Paction).

													English Grains.
Siliqua	Keration												3
3	Simplium												9
3 $\frac{3}{7}$	1 $\frac{1}{7}$	Sextans of Celfus											10 $\frac{2}{7}$
6	2	1 $\frac{2}{3}$	Scriptulum										18
18	6	5 $\frac{1}{4}$	3	Denarius of Nero									54
20 $\frac{4}{7}$	6 $\frac{6}{7}$	6	3 $\frac{5}{7}$	1 $\frac{1}{7}$	Denarius of Papyrius								61 $\frac{5}{7}$
24	8	7	4	1 $\frac{1}{2}$	1 $\frac{1}{8}$	Sextula							72
36	12	10 $\frac{1}{2}$	6	2	1 $\frac{3}{4}$	1 $\frac{1}{2}$	Sicilius						108
48	16	14	8	2 $\frac{2}{3}$	2 $\frac{1}{3}$	2	1 $\frac{1}{2}$	Duella					144
144	48	42	24	8	7	6	4	3	Uncia				432
1728	576	504	288	96	84	72	48	36	12	Mina			5184
				9600	8400	7200	4800	3600	1200	100	Centumpondium.		

WEIGHT.

TABLE IV.—Other Divisions of the Roman Pound (from Pauçon).

Uncia										English Grains.		
	-	-	-	-	-	-	-	-	-	432		
2	Sextans	-	-	-	-	-	-	-	-	864		
3	1 $\frac{1}{2}$	Quadrans, triunx, teruncium	-	-	-	-	-	-	-	1296		
4	2	1 $\frac{1}{3}$	Triens	-	-	-	-	-	-	1728		
5	2 $\frac{1}{2}$	1 $\frac{2}{3}$	1 $\frac{1}{4}$	Quincunx	-	-	-	-	-	2160		
6	3	2	1 $\frac{1}{2}$	1 $\frac{1}{3}$	Sexunx, femis	-	-	-	-	2592		
7	3 $\frac{1}{2}$	2 $\frac{1}{2}$	1 $\frac{3}{4}$	1 $\frac{2}{3}$	1 $\frac{1}{2}$	Septunx	-	-	-	3024		
8	4	2 $\frac{2}{3}$	2	1 $\frac{2}{3}$	1 $\frac{1}{3}$	1 $\frac{1}{2}$	Des, beffis, des	-	-	3456		
9	4 $\frac{1}{2}$	3	2 $\frac{1}{4}$	1 $\frac{3}{4}$	1 $\frac{1}{2}$	1 $\frac{2}{3}$	1 $\frac{1}{8}$	Dodrans, nonuncium	-	3888		
10	5	3 $\frac{1}{3}$	2 $\frac{1}{2}$	2	1 $\frac{2}{3}$	1 $\frac{1}{2}$	1 $\frac{1}{4}$	1 $\frac{1}{8}$	Dextans	4320		
11	5 $\frac{1}{2}$	3 $\frac{2}{3}$	2 $\frac{2}{3}$	2 $\frac{1}{3}$	1 $\frac{5}{6}$	1 $\frac{1}{2}$	1 $\frac{3}{8}$	1 $\frac{1}{8}$	1 $\frac{1}{10}$	Deunx	4752	
12	6	4	3	2 $\frac{2}{3}$	2	1 $\frac{5}{6}$	1 $\frac{1}{2}$	1 $\frac{1}{3}$	1 $\frac{1}{5}$	1 $\frac{1}{4}$	Libra, as, pondo	5184

The weight of the Roman denarius, ounce, and pound, is otherwise stated as follows :

By Arbuthnot, the Denarius, (7th part of the Ounce)	}	English Grains.	
the Ounce			62,4
the Pound			437,2
the Pound			5246,4
By Christiani, the Denarius, (8th part of the Ounce)	}		
the Ounce			51,9
the Ounce			415,1
the Pound			4981,2

See DENARIUS.

Modern Weights, or rather weights used in modern times, are in general very remote in their origin. We shall begin with British weights, and follow with those of France, making accurate comparisons between both; after which the divisions of the weights of the principal trading places in Europe, and other parts of the world, will be given; with tables of their relative proportions, extracted, by permission, from the Universal Cambist.

English Weights.—By the twenty-seventh chapter of *Magna Charta*, the weights are to be the same all over England; but for different commodities there are two sorts, viz. troy weight, and avoirdupois weight.

The origin from which they are both raised is the grain of wheat, gathered in the middle of the ear: 32 of these well dried make one penny-weight, 20 penny-weights 1 oz., and 12 oz. 1 lb. troy. Stat. 51 Hen. III. 31 Edw. I. 12 Hen. VII.

By the laws of assize, from the reign of William the Conqueror to the reign of Henry VII., the legal pound weight contained a pound of 12 ounces, raised from 32 grains of wheat; and the legal gallon measure invariably contained 8 of those pounds of wheat, 8 gallons made a bushel, and 8 bushels a quarter.

Henry VII. altered the old English weight, and introduced a pound, under the name of troy, which exceeded

the old Saxon pound by $\frac{1}{3}$ of an ounce: in proof of this it is alleged, that Henry VIII. when he abolished the old pound in the eighteenth of his reign, and established the troy, declares that the troy pound exceeded the old pound by $\frac{1}{3}$ of an ounce.

This troy pound now in use, consisting of 12 ounces, contains 5760 troy grains, and the ounce therefore contains 480 grains; consequently 360 grains, equal to $\frac{3}{8}$ of the ounce, deducted from 5760, leave 5400 troy grains, equal to the weight of the old Saxon pound which he abolished. It appears, therefore, that the old Saxon pound was $\frac{4}{7}$ of the present troy pound; and as the avoirdupois pound of 16 ounces contains 7000 troy grains, the old Saxon pound was $\frac{3}{7}$ of the present avoirdupois pound.

Although formerly 32 grains made a penny-weight, it has in later times been thought sufficient to divide the penny-weights into 24 equal parts called grains, being the least weights now in common use.

The first statute that directs the use of the avoirdupois weight is that of 24 Henry VIII., which plainly implies that it was no legal weight till that statute gave it a legal sanction; and the particular use to which the said weight is thus directed, is simply for weighing butcher's meat in the market. How or when it came into private use is not clearly known. Phil. Transf. vol. lxx. part i. art. 3.

TABLE V.—Of Troy Weight, as used by the Goldsmiths, &c.

Grains.		
24	Penny-weight.	
480	20	Ounce.
5760	240	12 Pound.

The grain troy is divided into 20 mites, the mite into 24 doits,

WEIGHT.

doits, the doit into 20 perioits, and the perioit into 24 blanks. These divisions are imaginary, but there are real weights of decimal divisions to the thousandth part of a grain.

TABLE VI.—Of Troy Weight, as used by the Apothecaries.

Grains.			
20	Scruple. ʒ		
60	3	Drachm. ʒ	
480	24	8	Ounce. ʒ
5760	288	96	12 Pound.

This weight is essentially the same as troy weight, but differently divided. It is chiefly used for medical prescriptions: but drugs are mostly bought and sold by avoirdupois weight.

TABLE VII.—Diamond Weight.

Diamonds and other precious stones are weighed by carats, the carat being divided into 4 grains, and the grain into 16 parts. The diamond carat weighs $3\frac{1}{2}$ grains troy: thus,

Diamond Weight.	Troy Weight.
16 Parts = 1 Grain	= $\frac{1}{16}$ Grain.
4 Grains = 1 Carat	= $3\frac{1}{2}$ Grains.

TABLE VIII.—Of Avoirdupois Weight.

Drachms.				
16	Ounce.			
256	16	Pound.		
7168	448	28	Quarter.	
28672	1792	112	4	Hundred.
573440	35840	2240	80	20 Ton.

The drachm is subdivided into three scruples, and each scruple into ten grains; the pound or 7680 grains avoirdupois = 7000 grains troy, and hence 1 grain troy = 1097 grains avoirdupois.

Hence also - 144 lb. avoirdupois = 175 lb. troy.
And - 192 oz. ditto - - 175 oz. do.

The stone is generally 14 lb. avoirdupois weight, but for butcher's meat or fish it is 8 lb. Hence the hundred equals 8 stone of 14 lb. or 14 stone of 8 lb.

A stone of glass is 5 lb. A seam of glass 24 stone, or 120 lb.

The fother of lead is generally $19\frac{1}{2}$ cwt.
at Newcastle, 21 cwt.
at Stockton, 22 cwt.

Hay and straw are sold by the load of 36 trusses.

The truss of hay weighs 56 lb. and of straw 36 lb. The truss of new hay is 60 lb. until the 1st of September.

A view of local varieties of English weights will follow the present article.

TABLE IX.—Wool Weight.

Wool, like other common articles, is weighed by the avoirdupois, but the divisions differ from the above table: thus,

7 Pounds	-	-	=	1 Clove
2 Cloves	-	-	-	1 Stone
2 Stone	-	-	-	1 Tod
$6\frac{1}{2}$ Tods	-	-	-	1 Wey
2 Weys	-	-	-	1 Sack
12 Sacks	-	-	-	1 Last.

The Weights of Ireland are the same as those of England; and they are used for corn instead of measures, which seems to be the most correct method of dealing.

Weights of Scotland.—By the act of union passed in 1707, the weights and measures of England were to be adopted in Scotland, but their introduction there is by no means general.

The English troy weight and apothecaries' weight, however, are used throughout Scotland, in the same manner as in England, with the exception that the Scotch jewellers divide the troy ounce into 16 drops, each drop being 30 troy grains; whereas the English divide it into 20 penny-weights, and a penny-weight into 24 grains, as before stated.

The English avoirdupois weight is used for the sale of leather, soap, sugar, tea, flour, candles, and other groceries; also for selling rosin, wax, pitch, wrought metals, some Baltic goods, and all goods brought from England.

Scotch troy weight, also called *Amsterdam* and *French Weight*, is used for weighing iron, hemp, flax, Baltic and Dutch goods, meal, butcher's meat, unwrought pewter and lead, and likewise for some more articles. The pound, 16 of which compose a stone, contains 7616 troy grains: it is consequently nearly 9 per cent. heavier than avoirdupois, or 100 lbs. are equal to 108½ lbs. avoirdupois.

Trone Weight.—This weight was abolished by act in 1618. Its name is still retained in selling butter, cheese, tallow, wool, lint, hemp, hay, and some other home commodities; but the trone stone and pound are generally denominated by avoirdupois pounds and ounces. The trone pound always contains the same number of ounces avoirdupois, as the stone contains pounds. The weight of the stone, however, is variable. It appears from a recent publication (Kelly's Metrology), that there are about thirty different systems of weights and measures in Scotland.

Weights of France.—In order fully to explain this important part of our article, three different weights must be noticed; viz. the ancient system, called the "Poids de Marc;" the "Metrical System," begun in 1795; and the "Systeme Usuel," sanctioned by an Imperial decree of 1812.

The old French weight (poids de marc), the pound or livre, contains 2 marcs, 16 ounces, 128 gros, 384 deniers, and 9216 grains, and equals 7556 grains troy. The new or metrical system, also called the decimal system, has been already explained under our article STANDARD. The following are its divisions, with its proportion to the poids de marc and English troy weight. The gramme is the element of all weights, and it is multiplied and divided by tens in the following terms:

The word <i>Deca</i> prefixed means	-	-	10 times.
<i>Hecto</i>	-	-	100 times.
<i>Kilo</i>	-	-	1000 times.
<i>Myria</i>	-	-	10000 times.

On the contrary, for divisors, the word *Deci* expresses the

10th part,	-	-	-
<i>Centi</i>	-	-	100th part, and
<i>Milli</i>	-	-	1000th part.

WEIGHT.

TABLE X.

	Poids de Marc.		Eng. Troy Weight.			
	livres. on.	gros. grs.	lb.	oz.	dwt.	grs.
Bar or Cubic Metre of Water.	2042	14 0 14	- 2681	3	6	2
Myriagramme	20	6 6 63.5	- 26	9	15	1.46
Kilogramme	- 2	0 5 35.15	- 2	8	3	12.146
Hectogramme	- -	3 2 10.715	- 3	4		8.414
Decagramme	- -	2 44.2715	- 6			10.441
Gramme	- -	18.82715	-			15.4441
Decigramme	- -	1.882715	-			1.54441
Centigramme	- -	0.1882715	-			0.15444

The gramme weighs 5.648 drachms avoirdupois, and the kilogramme 35.3 oz. or 2 lb. 3 oz. 4.8 drachms avoirdupois. The *Quintal Metrique*, therefore, weighs 1 cwt. 3 qrs. 24 lb. avoirdupois.

The pound of the *Système Usuel*, is the half kilogramme; but the divisions are binary, according to the ancient system.

Weights of Spain.—The Castilian mark is used for the precious metals. In weighing gold, it is divided into 50 castellanos, 400 tomines, or 4800 grains; but for silver, the same mark is divided into eight ounces, 64 ochavos, 128 adarmes, 384 tomines, or 4608 grains. The commercial weight is also Castilian. The pound is divided into 2 marks, 16 ounces, 128 drachms, or 9216 grains.—25 pounds = 1 arroba; 4 arrobas = 1 quintal.

Weights of Portugal.—Gold and silver are weighed by the mark of 8 ounces; the ounce being subdivided into 8 outavas, 24 escrupulos, or 576 grains. The commercial pound is divided into 2 marks or 16 ounces, the ounce into 8 outavas or 576 grains.—32 lb. = 1 arroba; 4 arrobas = 1 quintal.

Weights of Holland.—Gold and silver are weighed by the mark of 8 ounces. The ounce is divided into 20 engels or esterlins; the engel into 32 aas. Thus the mark weighs 5120 aas. The commercial pound is 40 aas heavier than the above pound troy. It is divided into 2 marks, 16 ounces, 32 loots, or 128 drachms.—8 lb. = 1 stone; 15 lb. = 1 lispond; 100 lb. = 1 centner; and 300 lb. = 1 shippond.

A new system of monies, weights, and measures, similar to the decimal system of France, has been lately decreed for Holland, Brabant, and Flanders, by the king of the Netherlands.

Weights of Germany.—The weight for gold and silver is not the same in all parts of Germany, but the Cologne mark is every where the standard weight for coins. It is divided into 8 ounces, 16 loths, 256 pfenings, 512 hellers, 4352 eschen, or 65536 richt-pfenings. The pound or pfund commercial weight is generally divided into 2 marks, 16 ounces, 32 loths, 128 quintins, 512 pfenings, 1024 hellers. The larger weights are the shippond, the centner or quintal, the lispond, and the stein; but they do not in all places contain the same number of pounds, and their divisions as well as relative proportions are extremely various throughout the empire.

Weights of Italy.—The weights of Italy are various both in their divisions and relative proportions. Thus, at Rome, the pound for weighing gold and silver is divided into 12 ounces, the ounce into 12 drachms, 24 denari or scrupoli, 48 oboli, 144 filique or 576 grani. At Naples, the pound or libra is divided into 12 ounces, the ounce into 30 trapesi, and

the trapeso into 20 acini. At Genoa, Florence, Leghorn, and Milan, it is divided into eight ounces, the ounce into 24 denari or 576 grani. At Venice, the marc is divided into 8 oncie, 32 quarti, 192 denari, 1152 carati, or 4608 grani. The commercial weight in most of the above places is the same for light goods as for gold and silver, and is called peso sottile; but a heavier weight is used for coarse commodities, and is called peso grosso. Their cantaro or quintal varies from 100 to 250 lb., and in some places the great cantaro is 1000 lb.

Weights of Denmark.—The pound for gold and silver contains 2 marks, 16 ounces, 32 lots, 128 quintins, or 512 ort or pfenings. The pound commercial weight is divided like that for the precious metals. The shippond contains 320 lbs. 20 lisponds, or 3½ centners.

Weights of Sweden.—The mark for the precious metals contains 4384 aas; but for commercial purposes there are four other weights, viz. the victualie-wigt, divided into 32 lods or 128 quintins; the bergs-wigt or miner's weight, the landstads-wigt, and the metal-wigt. The pound of each of the three latter is divided into 16 lods, or 64 quintals.

Weights of Russia.—The pound in Russia used for all commodities is divided into 32 loths, or 96 solotnicks.—40 lb. = 1 pood, and 10 poods = 1 berquet.

Weights of Asia.—The weights of Asia are far too numerous and various in their divisions for our limits; but it may be observed, that decimal divisions are more general there than in Europe.

Weights of Africa.—Upon the Barbary coast and in Egypt, the weights are similar to each other in their divisions, but very different in their relative proportions. The principal weight is the cantaro, divided into 100 rottoli, which is likewise used in Italy, Constantinople, and several places in the Levant.

Weights of America.—The weights and measures generally used in America, are those of the countries by which the different settlements were originally colonized. Thus the Spanish weights are retained in all parts of South America except Brazil, where those of Portugal are used. In the United States of North America, the English system of weights and measures is still continued, although several plans have been proposed for changing them.

Comparison of Weights.—The following Tables shew the relation between English and foreign weights. Also the proportion of the latter to each other, which is found by a single stating in the Rule of Three, as in the following examples:

Example 1.—How many marks of Berlin weight are equal to 560 kilogrammes of France?

Because 159.29 marks of Berlin = 100 lb. English Troy (*per* Table XI.), and 37.31 kilogrammes, by the same Table, = 100 lb. English Troy; it follows that 37.31 kilogrammes = 159.26 marks of Berlin; therefore, say,

$$\text{As } 37.31 \text{ kilog.} : 159.29 \text{ marks} :: 560 \text{ kilog.} : 2390.84 \text{ marks.}$$

Example 2.—How many pounds commercial weight of Amsterdam are equal to 276 pounds of Leghorn?

Here, by Table XII., 91.81 lb. of Amsterdam = 133.56 lb. of Leghorn, both being equal to 100 lb. Avoirdupois; therefore,

$$\text{As } 133.56 \text{ lb. of Leghorn} : 91.81 \text{ lb. of Amsterdam} :: 276 \text{ lb. of Leghorn} : 189.7 \text{ lb. of Amsterdam.}$$

WEIGHT.

TROY WEIGHT.

TABLE XI.—Containing a Comparison of the Troy, or Gold and Silver Weights of different Countries; and shewing the Number of Pounds, Marks, Ounces, &c. of each Place, that are equal to 100 Pounds English Troy; and also the Weight of a single Pound, Mark, Ounce, &c. in English Troy Grains.

		Weight of 100 lbs. English Troy.	Weight of a single lb. Mark, &c.		Weight of 100 lbs. English Troy.	Weight of a single lb. Mark, &c.
			E. Grains.			E. Grains.
Amsterdam	Marks - - - -	151.68	3797½	Leghorna	- - (See Florence.)	
Antwerp	The same - - - -			Leipfic	- - (See Cologne.)	
Angsburg	Marks - - - -	158.11	3643	Lifbon	- - Marks - - - -	162.62
Bafil	(See Cologne.)			Lubec	- - (See Cologne.)	
Berlin	Marks - - - -	159.29	3616	Madras	- - Seers - - - -	134.17
Bern	Marks - - - -	151.18	3810		Pagodas - - - -	10919.40
Bombay	Tolas - - - -	3232.32	178½		Rupees - - - -	3217.87
Bremen	(See Cologne.)			Madrid	- - (See Spain.)	
Bresslau	Marks - - - -	182.39	3158	Malabar	- - (See Madras.)	
Brussels	(See Amsterdam.)			Malta	- - Libre - - - -	117.83
Cadiz	(See Spain.)			Milan	- - Marks - - - -	158.75
Cairo	Rottoli - - - -	86.56	6654		Ounces - - - -	1270
Calicut	Miscals - - - -	8347.82	69	Naples	- - Libre - - - -	116.36
China	Tales - - - -	993.79	579¾		Oncie - - - -	1396.32
Cologne	Marks - - - -	159.64	3608	Nuremberg	- - Marks - - - -	156.95
Constantinople	Chekies - - - -	117	4922½	Paris	- - (See France.)	
	Drams - - - -	11700	49¼	Pegu	- - Ticals - - - -	2426.82
Cracow	Marks - - - -	187.68	3069	Persia	- - Miscals - - - -	8022.25
Damascus	Metecals - - - -	8347.82	69	Poland	- - Marks - - - -	185
Dantzic	Marks - - - -	195.42	2947½	Portugal	- - (See Lisbon.)	
Denmark	Marks - - - -	158.89	3625	Prague	- - Marks - - - -	147.09
England	Pounds Troy - - - -	100	5760	Ratisbon	- - Marks - - - -	151.68
	Ounces do. - - - -	1200	480	Riga	- - Marks - - - -	178.43
Florence	Pounds - - - -	109.90	5241	Rome	- - Libre - - - -	110
	Oncie - - - -	1318.83	436¾	Ruffia	- - Pounds - - - -	91.23
Frankfort	(See Cologne.)				Solotnicks - - - -	8758
France	Marks - - - -	152.44	3780	Sienna	- - Libre - - - -	111.22
	Ounces - - - -	1219.52	472	Spain	- - Marks - - - -	161.87
	Kilogrammes - - - -	37.31	15444		Ounces - - - -	1294.96
	Hectogrammes - - - -	3731.53	1543¾		Castellanos - - - -	8093.50
Geneva	Marks - - - -	152.15	3785½	Surat	- - Tolas - - - -	3066.55
	(Or like France.)			Sweden	- - Marks - - - -	177.12
Genoa	Libre - - - -	117.45	4904	Tripoli	- - Metecals - - - -	7819
	Oncie - - - -	1409.40	408¾	Tunis	- - Ounces - - - -	1185.20
Hamburgh and	} (See Cologne.)			Turin	- - Marks - - - -	151.68
Hanover				Venice	- - Marks - - - -	156.44
Holland	(See Amsterdam.)			Vienna	- - Marks - - - -	132.88
Konigsberg	Marks - - - -	190.50	3023½	Zurich	- - Marks - - - -	159.27

WEIGHT.

AVOIRDUPOIS WEIGHT.

TABLE XII.—Containing a Comparifon of the Commercial Weights of different Places; and fhewing the Number of Pounds, &c. of each Place that are equal to 100 Pounds Avoirdupois; and alfo the Weight of a fingle Pound, &c. in English Troy Grains, 7000 of which weigh one Pound Avoirdupois.

		Weight of 100 lbs. Avoirdupois.	Weight of a fingle lb. Mark, &c.			Weight of 100 lbs. Avoirdupois.	Weight of a fingle lb. Mark, &c.
		E. Grains.				E. Grains.	
Aix la Chapelle	Pounds - - -	96.76	7234	Calemburg	Pounds - - -	93.19	7511
Aleppo	Rottoli of 720 drs.	19.89	35190	Calicut	Seyras - - -	163.05	4293
	Do. of 700 drams	20.46	34212	Candia	Rottoli - - -	85.91	8148
	Do. of 680 drams	21.06	33235	Carthage	(See Spain.)		
	Do. of 600 drams	23.87	29325	Caffile	Pounds - - -	93.32	7501
	Okas of 400 drams	35.80	19550	Castile	(See Spain.)		
Alexandria	Rottoli Forfori	107	6542	Chamberry	Pounds - - -	105.72	6621
	Zaydini - - -	74.90	9345	China	Catties - - -	75.45	9277
	Zauri - - -	48.32	14485	Civita Vecchia	Pounds - - -	132.90	5267
	Mine - - -	59.92	11682	Cologne	Pounds - - -	97	7216
Algiers	Rottoli - - -	84	8330	Conftance	Pounds - - -	96.09	7285
Alicant	Great pounds - -	87.48	8002	Conftantinople	Okas - - -	35.55	19688
	Light pounds - -	131.20	5335		Lodras - - -	80.80	8663
Altona	(See Hamburg.)				Chekies - - -	142.22	4922
Amfterdam	Pounds - - -	91.80	7625	Copenhagen	Pounds - - -	90.80	7725
Ancona	Pounds - - -	136.05	5145	Corfu	Pounds - - -	111	6304
Antwerp	Pounds - - -	96.75	7235	Corfica	Pounds - - -	131.72	5315
Apothecaries' Weight.				Cracow	Pounds - - -	112	6250
	English pounds - -	121.52	5760	Cremona	Pounds - - -	138.33	5060
	Dutch pounds - -	122.89	5696	Cyprus	Rottoli - - -	19.07	36708
	German pounds - -	126.65	5527	Damafcus	Rottoli - - -	25.28	27690
	French pounds (of } 12 ounces) - - -	123.50	5668	Dantzic	Pounds - - -	103.07	6791
Archangel	(See Ruffia.)			Denmark	(See Copenhagen.)		
Augsburg	Heavy pounds - -	92.35	7580	Deventer	Pounds - - -	96.43	7259
	Light pounds - -	95.95	7295	Drefden	Pounds - - -	97.14	7206
Aurich	Heavy pounds - -	83	8433	Dunkirk	Pounds - - -	105.86	6612
	Light pounds - -	91.10	7666	Elbing	Pounds - - -	106.73	6558
Bamberg	Pounds - - -	93.42	7493	Embden	Pounds - - -	91.29	7668
Barcelona	Pounds - - -	112.60	6216	England	Avoirdupois pounds	100	7000
Bafil	Pounds - - -	92.64	7556	Erfurt	Pounds - - -	96.08	7285
Baffano	Pounds - - -	132.82	5270	Ferrara	Pounds - - -	133.67	5237
Batavia	Catties - - -	76.78	9117	Florence	Pounds - - -	133.56	5241
Bengal	Seers - - -	53.57	13066	Frankfort	Pounds - - -	97.02	7210
Bergamo	Light pounds - -	139	5032	France, Poids de Marc	pounds - - -	92.64	7556
	Heavy pounds - -	55.64	12580		Kilogrammes - -	45.35	15436
Bergen	Pounds - - -	91	7700		Hectogrammes - -	453.50	15435
Berlin	Pounds - - -	96.80	7231	Gallipoli	(See Naples.)		
Bern	Pounds - - -	86.85	8060	Geneva	Heavy pounds - -	82.35	8502
Betelfagui	Maunds - - -	49.04	14273		Light pounds - -	98.82	7085
Bilboa	Light pounds - -	92.59	7560	Genoa	Pefo groffo Rottoli	92.86	7538
	Iron weight pounds	63.42	11037		Pefo fottile pounds	142.74	4904
Bologna	Pounds - - -	125.31	5586	Gothenburg	(See Sweden.)		
Bolfano	Pounds - - -	90.61	7725	Groningen	Pounds - - -	92.69	7552
Bourdeaux	Pounds - - -	91.72	7632	The Hague	(See Amfterdam.)		
Bremen	Pounds - - -	90.93	7698	Hamburgh	Pounds - - -	93.63	7476
Brefcia	Pounds - - -	138.62	5050	Hanover	Pounds - - -	93.20	7511
Brefflau	Pounds - - -	111.90	6255	Havre-de-Grace	Pounds - - -	85.78	8160
Brunfwick	Pounds - - -	97.14	7206	Heidelberg	Pounds - - -	89.89	7787
Bruffels	(See Antwerp.)			Hildefheim	(See Brunfwick.)		
Cadiz	(See Spain.)			Holland	(See Amfterdam.)		
Cairo	Rottoli - - -	105	6664	Holftein	Pounds - - -	93.83	7460
				Japan	Catties - - -	76.92	9100

WEIGHT.

TABLE XII.—*continued.*

	Weight of 100 lbs. Avoirdupois.	Weight of a single lb. Mark, &c.		Weight of 100 lbs. Avoirdupois.	Weight of a single lb. Mark, &c.
		E. Grains.			E. Grains.
Kiel - - - Pounds - - - -	95.18	7354	Nice - - - Pounds - - - -	146.25	4786
Konigsberg - Pounds - - - -	119.27	5869	Nimeguen - - Pounds - - - -	91.65	7638
New (See <i>Berlin.</i>)			Nordlingen - Pounds - - - -	92.53	7565
Leghorn - - Pounds - - - -	133.56	5241	Norway - - - (See <i>Bergen.</i>)		
Leipfic - - Pounds - - - -	97.14	7206	Novi - - - - (See <i>Genoa.</i>)		
Butcher's weight lb.	90	7771	Nuremberg - Pounds - - - -	88.94	7870
Liebau - - Pounds - - - -	109.84	6373	Oldenburg - (See <i>Hamburg.</i>)		
Liege - - Pounds - - - -	95.49	7330	Oporto - - - (See <i>Lisbon.</i>)		
Lindau - - Heavy pounds -	78.58	8908	Oran - - - Rottolos - - -	90	7775
Light pounds - - -	93.23	7126	Ormus - - - Seyras - - - -	149.73	4675
Lisbon - - Pounds - - - -	98.80	7085	Osnaburg - Pounds - - - -	91.80	7625
Lisle - - Pounds - - - -	105.61	6628	Oftend - - - (See <i>Antwerp.</i>)		
London - - (See <i>England.</i>)			Paderborn - (See <i>Munster.</i>)		
Lubec - - Pounds - - - -	93.83	7460	Padua - - - Pefo Sottile pounds	133.33	5250
Lucca - - Pounds - - - -	135.59	5163	Pefo Grosso, (See <i>Venice.</i>)		
Lucern - - Pounds - - - -	94	7447	Palermo - - (See <i>Sicily.</i>)		
Luneburg - (See <i>Hanover.</i>)			Paris - - - (See <i>France.</i>)		
Lyons - - Poids de table pound	105.87	6612	Parma - - - Pounds - - - -	139.33	5024
Silk weight pound	98.81	7084	Paffau - - Pounds - - - -	94.41	7414
Madeira - Pounds - - - -	104.10	6724	Pegu - - - Vis - - - -	30	23333
Madras - - Vis - - - -	32	21875	Pernau - - Pounds - - - -	108.86	6430
Pollams - - -	1280	547	Perugia - - Pounds - - - -	130	5382
Madrid - - (See <i>Spain.</i>)			Pillau - - Pounds - - - -	113.56	6164
Magdeburg - (See <i>Berlin.</i>)			Pifa - - - Pounds - - - -	139.22	5028
Majorca - - Rottolos - - - -	107.82	6492	Poland - - - (See <i>Warsaw.</i>)		
Malabar - - (See <i>Calicut.</i>)			Pondicherry - Vis - - - -	30.88	22668
Malacca - - Catties - - - -	74.07	9450	Portugal - - (See <i>Lisbon.</i>)		
Malaga - - (See <i>Spain.</i>)			Prague - - Pounds - - - -	88.16	7940
Malta - - Pounds - - - -	143.20	4888	Prezburg - - (See <i>Vienna.</i>)		
Manheim - Pounds - - - -	91.65	7638	Ragufa - - Pounds - - - -	124.84	5607
Mantua - - Pounds - - - -	143.70	4871	Ratifbon - - Pounds - - - -	79.81	8771
Marfeilles - Pounds - - - -	111.63	6271	Ravenna - - Pounds - - - -	151.42	4628
Mecca - - Rottoli - - - -	98	7144	Reggio - - Pounds - - - -	137.48	5092
Mecklenburg - Pounds - - - -	93.86	7458	Revel - - Pounds - - - -	105.32	6646
Memel - - Pounds - - - -	109.82	6374	Riga - - Pounds - - - -	108.46	6454
Messina - - (See <i>Sicily.</i>)			Rochelle - - (See <i>France.</i>)		
Milan - - Pefo Grosso pounds	60.39	11592	Rome - - Pounds - - - -	133.69	5236
Pefo Sottile pounds	140.90	4968	Rostock - - Pounds - - - -	88.75	7887
Minorca - - Heavy pound - -	37.88	18480	Rotterdam - Pounds - - - -	91.80	7625
Light pound - - -	113.63	6160	Light weight pound	96.39	7262
Mocha - - Maunds - - - -	33.33	21000	Rouen - - - Poids de Vicomté } Pounds - - - - }	87.40	8009
Vakias - - - -	133335	525	Ruffia - - Pounds - - - -	110.86	6314
Modena - - Pounds - - - -	141.93	4932	Saltzburg - Pounds - - - -	81	8642
Monaco - - Pounds - - - -	136.87	5114	St. Gall - - Heavy pounds -	77.58	9022
Montpellier - Com. weight pounds	113.58	6163	Light pounds -	97.55	7176
Morea - - Silk weight pounds	113.50	6167	St. Maloes - (See <i>France.</i>)		
Pounds - - - -	90.79	7710	St. Remo - - (See <i>Genoa.</i>)		
Okas - - - -	37.83	18503	St. Sebastian - Pounds - - - -	92.64	7556
Moscow - - (See <i>Russia.</i>)			Sardinia - - Pounds - - - -	114.29	6125
Munich - - Pounds - - - -	80.87	8656	Sayde - - - Rottoli of Damascus	24.35	28746
Munster - Pounds - - - -	95.31	7344	Ditto of Acre -	20.75	33740
Nantes - - (See <i>France.</i>)			Scotland - - Pounds Dutch - } Weight - - - }	92.11	7600
Naples - - Rottoli - - - -	50.91	13750	Siam - - - Catties - - - -	38.76	18060
Libre - - - -	141.41	4950	Sicily - - - Rottoli Grossi -	51.93	13475
Narva - - Pounds - - - -	96.84	7228	Ditto Sottili -	57.14	12250
Negropont - Rottoli - - - -	84.73	8261	Libre - - - -	142.85	4900
Neufchatel - Poids de Marc, (See <i>France.</i>)			Pounds - - - -	101.38	6904
Poids de Fer pounds	87.18	8029	Sienna - - Pounds - - - -		

WEIGHT.

TABLE XII.—*continued.*

	Weight of 100 lbs. Avoirdupois.	Weight of a single lb. Mark, &c.		Weight of 100 lbs. Avoirdupois.	Weight of a single lb. Mark, &c.
			E. Grains		E. Grains.
Smyrna - - Okes - - - -	36.51	19172	Tripoli (in Syria) Okes - - - -	37.45	18691
- - Rottoli - - - -	81.13	8628	Tripoli (in Africa) Rottoli - - - -	89.28	7840
Spain - - - Castilian weight lb.	98.40	7114	Tunis - - - Ditto - - - -	90.09	7770
Stade - - - Pounds - - - -	95.46	7333	Turin - - - Pounds - - - -	122.93	5694
Stettin - - - (See <i>Berlin.</i>)			Ulm - - - Pounds - - - -	96.77	7234
Stockholm - - (See <i>Sweden.</i>)			Valencia - - Heavy pounds - -	84.72	8262
Stralfund - - Pounds - - - -	93.83	7460	- - Light pounds - -	127.08	5508
Strafburg - - Pounds - - - -	96.34	7266	Venice - - - Pefo Grosso pounds	94.74	7389
- - Or, like <i>France.</i>			- - Pefo Sottile pounds	150	4667
Sumatra - - Catties - - - -	35.56	19683	Verona - - - Pefo Grosso pounds	91.19	7676
Surat - - - Seers - - - -	107.14	6533	- - Pefo Sottile pounds	136.35	5134
Surinam - - - (See <i>Amsterdam.</i>)			Vicenza - - Pefo Grosso pounds	92.75	7547
Sweden - - - Viſtualie weight			- - Pefo Sottile pounds	133.33	5250
- - Pounds - - - -	106.67	6562	Vienna - - Pounds - - - -	81	8638
- - Miner's weight	120.68	5800	Warsaw - - Old weight pounds	120	5832
- - Marks - - - -			- - New Polish wt. }	112.25	6236
- - Landtatt weight	126.70	5525	Wifmar - - Pounds - - - -	93.76	7466
- - Marks - - - -			Wurtzburg - Pounds - - - -	95.08	7362
- - Stapeltatt weight	133.33	5250	Yvica - - - Pounds - - - -	97.97	7145
- - Marks - - - -			Zant - - - (See <i>Venice.</i>)		
Tangiers - - Pounds - - - -	94.27	7425	Zell - - - (See <i>Hanover.</i>)		
Teneriffe - - Pounds - - - -	98.77	7087	Ziriczee - - Pounds - - - -	103.94	6735
Tetuan - - - Rottoli - - - -	63.96	10944	Zurich - - - Heavy pounds - -	86.03	8136
Toulon - - - (See <i>Marseilles.</i>)			- - Light pounds - -	96.78	7233
Trieste - - - (See <i>Venice</i> and <i>Vienna.</i>)			Zwoll - - - Pounds - - - -	94.10	7439

Plan for the Revision of foreign Weights, &c.—The commercial world will learn with satisfaction that a plan has lately been commenced, under the auspices of the British government, for revising the tables of comparison between foreign weights and measures; as it is well known that many of the tables in use abound in contradictory statements; and even where they agree, they are frequently found to differ from mercantile experience.

The origin of those tables of comparison cannot be traced. It is probable that they have been gradually formed through a long course of ages, from the casual reports of individuals in different countries. When, therefore, it is considered, how uncertain such reports must have been, and also to what changes weights and measures are exposed from decay, accident, or design, it is not surprising that so much confusion should be experienced, especially in tables where no general revision has ever taken place.

The only comparison of the kind upon record is that made in 1767, by M. Tillet, at the Paris Mint, by order of the French government. His operations, however, were confined to money weights, and these only of a limited number of places. His tables, as far as they extend, have been generally used, although their accuracy is, in many instances, disputed, especially by Krufe, and other German writers. Nelkenbrecker, in his elaborate work on monies, weights, and measures, published at Berlin in 1810, gives a long statement (page 508.) of discrepancies between Tillet's reports and those of other assay masters.

But the most numerous and important errors are in the tables of commercial weights and measures; and therefore with a view of remedying an evil so perplexing to merchants, our government has recently issued an order to the British consuls abroad, to send home well-attested copies of foreign standard weights, that they may be accurately compared with those of England at his majesty's mint. Correct statements are likewise required of the mathematical dimensions of measures of capacity, and of their comparative contents, as estimated and acted upon by merchants.

We have authority further to state, that the plan was examined and approved by the Board of Trade, on the 14th of January 1818; and, by their lordships' recommendation, the order to the consuls has been issued from the foreign-office, by Viscount Castlereagh.

The copies of standards thus transmitted to London are to be weighed and compared by Robert Bingley, esq. F.R.S., the king's assay-master of the Mint; and the results of those important comparisons are to be published by Dr. Kelly, who projected the plan, and who will perform the calculations. The revised tables are expected to be brought out in the second edition of his *Cambist*; and should they be printed before our *Cyclopædia* is finished, we hope for the author's permission to insert them in our *Addenda*.

WEIGHTS.

Weights and Measures, in Agriculture and Rural Economy, are of great consequence to the land-owner and the farmer, as being the proportions or quantities by which various sorts of produce, of the agricultural and other such kinds, are disposed of and sold. They are found to vary very greatly in different districts and parts of the country, as well as in different places and towns of the same district or county, and even in the markets of the same town. Consequently, the confusion, uncertainty, inconvenience, and loss which are thus produced, are often very great and troublesome. We have already, in the preceding article, observed, that the two principal weights established in Great Britain are the troy and avoirdupois weights, and by these most of the articles of farm produce, and those of many other kinds, are sold in this country.

There are some, however, that are disposed of in other ways, as will be seen below.

However, as the diversity of weights and measures (in different places) creates much perplexity and uncertainty in the purchase as well as disposal of different sorts of produce, it would not only be highly desirable, but convenient and advantageous, to have one universal standard or system of weights and measures. For an account of the attempts that have been made to obtain such a standard, see **STANDARD.**

Different Weights and Measures for Farm and other produce by Troy Weight.

24 Grains	make	1 Pennyweight
20 Pennyweights	-	1 Ounce
12 Ounces	-	1 Pound.

By this weight are weighed gold, silver, amber, bread, corn, and all liquors.—14 oz. 11 dwts. 15½ grains, or 292 dwts. nearly, are equal to a pound avoirdupois.

By Avoirdupois Weight.

16 Drams	make	1 Ounce
16 Ounces	-	1 Pound
28 Pounds	-	1 Quarter
4 Quarters	-	1 Hund. weight
20 Hund. weight	-	1 Ton.

By this weight are weighed all the farm produce, such as butter, cheese, and many other articles; and all metals, except those of the finer kinds. In other cases,

7½ Pounds	make	1 Gallon of train-oil
8 Pounds	-	1 Stone of butcher's meat
14 Pounds	-	1 Stone of horseman's weight
19½ Hundreds	-	1 Fodder of lead.

In Wool Weight.

7½ Pounds	make	1 Clove
2 Cloves	-	1 Stone
2 Stone	-	1 Todd
6½ Todds	-	1 Weigh or Wey
2 Weys	-	1 Sack
12 Sacks	-	1 Last.

In Hay Weight.

56 Pounds of old hay, or	} make	1 Trufs
60 Pounds of new ditto		1 Load.
36 Trusses	-	-

In Bread Weight.

	lb.	oz.	dr.
A peck loaf weighs	-	-	17 6 ½
A half ditto	-	-	8 11 0
A quarter ditto	-	-	4 5 8

By Dry Measure.

2 Pints	make	1 Quart
2 Quarts	-	1 Pottle
2 Pottles	-	1 Gallon
2 Gallons	-	1 Peck
4 Pecks	-	1 Bushel
4 Bushels	-	1 Coomb
2 Coombs, or eight bushels	-	1 Quarter
4 Quarters, or 32 bushels in the country, and 36 in London	-	1 Chaldron
5 Quarters	-	1 Weigh or Wey
2 Weys, or 10 quarters	-	1 Last.

By this measure are measured corn, salt, lead, ore, oysters, different other such matters, and all dry goods. The standard Winchester bushel is a cylinder 18½ inches diameter, and 8 inches deep.

By Long Measure.

3 Barleycorns	make	1 Inchi
12 Inches	-	1 Foot
3 Feet	-	1 Yard
6 Feet	-	1 Fathom
5½ Yards	-	} 1 Pole, rod, or perch
40 Poles	-	
8 Furlongs	-	1 Mile
3 Miles	-	1 League
60 Geographical, or } 69½ English miles	-	1 Degree
360 Degrees	-	} The circumference of the Globe.

This comprehends length only, as in the above cases.

By Square Measure.

144 Square inches	make	1 Square foot
9 Square feet	-	1 Square yard
100 Square feet	-	1 Sq. of flooring
272¼ Square feet	-	1 Square rod
40 Square rods	-	1 Square rood
4 Square roods	-	1 Square acre
30 Square acres	-	} 1 Square yard of land
100 Square acres	-	
640 Square acres	-	1 Square mile.

Square measure comprehends length and breadth, and is used in measuring land, in paving, flooring, painting, glazing, plaistering, roofing, slating, tiling, and for several other rural purposes.

In land measuring is used Gunter's chain, which is 4 poles or 22 yards, or 66 feet long, and contains 100 links, each link being 7.92 inches long.

And 43560 square feet or 4840 square yards, or 160 square poles, that is, 160 poles in length and 1 pole in breadth, or 4 square roods, or 10 square chains, that is, 10 chains in length and 1 chain in breadth, make an acre of land.

By Cubic or Solid Measure.

1728 Cubic inches	make	1 Cubic foot
27 Cubic feet	-	1 Cubic yard
40 Feet of rough timber	}	1 Load
50 Feet of hewn ditto		

This comprehends length, breadth, and thickness.

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And

WEIGHTS.

And 108 solid feet, that is, 12 feet in length, 3 feet in breadth, and 3 deep, or commonly 14 feet long, 3 feet 1 inch broad, and 3 feet 1 inch deep, are a stack of wood.

And 128 solid feet, that is, 8 feet long, 4 feet broad, and 4 feet deep, are a cord of wood.

In Coal Measure.

4 Pecks	make	1 Bushel
3 Bushels	- - -	1 Sack
12 Sacks, or 36 bushels	- - -	1 Chaldron
21 Chaldrons	- - -	1 Score

In Corn Measure.

1 Load of corn	makes	5 Bushels
1 Laft of ditto	- - -	43 Do.

It is enacted by 31 George III., that a Winchester bushel of corn should weigh as follows :

	lb.		lb.	
Wheat	57	avoirdupois,	Wheat meal	56
Barley	49	- - -	Flour	48
Bigg	42	- - -	Ditto	41
Oats	38	- - -	—	32
Rye	55	- - -	—	53

} Flour, 45lb. of
} which should be
} equal to a Win-
} chester bushel
} unground.

After these statements of the different weights and measures which are in common use for different sorts of produce, it may not be improper to notice some of the differences of weights and measures, as they exist in different districts, towns, and parts of the kingdom, according to the account which has been given of them, and as they are injurious to the farmer.

In the counties or districts near the metropolis, the statute measures are pretty commonly employed, though there are many irregularities and deviations; but in those at some distance there are more frequent and remarkable variations and differences.

In the county of Middlesex, the weights and measures made use of are mostly those of the standard legal kind, and consequently the variations in them are but little.

Wood is sold by the stack, as packed three feet by three, and twelve feet long, containing in this manner 108 cubical feet.

Effex is now pretty much in the same state as above, in regard to its weights and measures, though formerly they varied very greatly, wheat being sold either by weight or measure, as agreed upon. The measure then eight gallons and a half the bushel; and the weight, that usually termed the peck weight, or the medium of what eight and a half of good wheat would weigh.

Then all other sorts of grain were sold by measure, but by that which was very different in different places, and for different sorts, the bushel of barley, malt, oats, &c. being often nine gallons; others eight and a half, and eight and three pints, &c. There are still some remains of these measures in the county. Various articles, too, are still sold there by the tale, the dozen, the score, and the hundred of six score, such as hop-poles, faggots, &c.

The writer of the Berkshire Agricultural Report remarks, that, notwithstanding the fines and forfeitures attached to selling corn by any other than the standard bushel, and the obvious ill consequences resulting from the practice without one counterbalancing advantage, that county, like most others, has its diversity of measures, which only encourages jobbers, to the prejudice of the grower of corn; who, influenced by habit, does not always take into consideration, that if he should sell nine gallons instead of eight

to the bushel, he is giving a bushel in every quarter of grain more than the laws allow, or justice requires, and that the dealer is probably making that proportion of profit, out of his ignorance or obstinacy.

The owners of land cannot, therefore, more effectually serve their tenants, it is supposed, than by exerting themselves to introduce an uniformity of measure in their respective neighbourhoods.

The nine-gallon bushel prevails in some parts of the county, but in others the standard. At Faringdon and Wantage, the former is almost exclusively used; but at Abingdon both it and the standard bushel are employed. The former is the custom of the market, however, unless the contrary be specified; but malt sold out of the town is only eight gallons measure.

Corn is commonly sold by the load of five quarters. In building, hedging, and ditching, the perch or pole of eighteen feet is the usual measure.

Wood is sold by the foot, and load-underwood by the cord, in some places absurdly called a load, and by the proper load.

Besides the statute acre, there are also common field acres, which are sometimes more, and sometimes less, than the statute.

In weights the diversity is great in most places.

In the county of Sussex, the weights and measures most commonly used are, the pound, stone, acre, load, bushel, &c. There are several sorts of acres, which are a great source of perplexity and confusion—the short acre, the statute acre, the forest acre, and various others: the forest acre is nine score rods; the statute, eight score; and the short acre, six score in some places, in others five score. The stranger, unaware of the variations that prevail in the weights and measures, is, it is said, liable to fall into mistakes in every step he takes; and that until a radical reform is brought to bear, the present confusion in buying and selling must prevail, and the honest and unsuspecting will be taken in by the crafty and designing.

In the other southern districts or counties, the variations in their weights and measures are much the same, though less than in those of the north.

It is stated in the Gloucester Report on Agriculture, that in the market of that town, the bushel varies from nine to ten gallons; in the forest district it is nearly ten gallons; on the Cotswolds about nine; in the vale nine and a half; and in the lower vale, and at Cirencester, nine and a quart, of all sorts of grain.

Near Bristol, potatoes, green peas, &c. are sold by the double peck, containing two common ones struck level with the top; while at Gloucester, and higher up the vale, it is a common peck heaped up. Wool is generally sold by the stone weight of 12½lbs., or the tod of 28½lbs. Butter often by the pound of 18 oz.; and the quart of about 3lbs.

In Herefordshire the peculiar weights and measures which are at present in use are these, according to the Survey on Agriculture for that district.

1 Pound of fresh butter	-	18 Ounces
1 Stone	- - -	12 Pounds
1 Customary acre	- - -	$\frac{2}{3}$ Of a statute acre
1 Hop acre	- - -	That space of ground which contains 1000 plants; viz. about $\frac{1}{2}$ a statute acre
1 Lugg	- - -	49 Square yards of cop-pice-wood

Wood

WEIGHTS.

1 Wood acre	-	-	$\frac{3}{8}$ Larger than a statute, <i>i. e.</i> as 8 are to 5
1 Day's math	-	-	About a statute acre of meadow or grass land, being the quantity usu- ally mown by one man in one day
1 Perch of fencing	-	7	Yards
1 Perch of walling	-	16 $\frac{1}{2}$	Feet
1 Perch of land	-	5 $\frac{1}{2}$	Yards (as statute)
1 Bushel of grain	-	10	Gallons
1 Bushel of malt	-	8 $\frac{1}{2}$	Gallons.

In the Report on Agriculture for Shropshire, it is stated, that wheat, barley, and peas, are sold by the strike or bushel, which, in Shrewsbury market, is 38 quarts, but in some other markets it is 40 quarts. That the 38 quarts of wheat should weigh 75lbs., the 40 quarts 80lb. In other markets in the county, the bushel of wheat does not weigh more than 70lbs.: this is chiefly applicable to the eastern district of the county. The bushel of flour is every where 56lbs. That 38 quarts of barley weigh about 65lbs. That a bushel of oats means three half bushels of the customary measure at Shrewsbury, and should weigh better than 93lbs. But that in other markets it means 2 $\frac{1}{2}$ bushels, sometimes heaped, sometimes stricken, and sometimes a medium between both. That a bag of wheat means three bushels customary measure. The quarter bushel is called a hoop or peck; and the fourth of that is called a quarter. Butter, when fresh, weighs 17oz. to the pound; when salted, 16 oz. The last is reckoned by the gawn, which signifies 12lbs. of 16 oz. in Shrewsbury, and 16lbs. of 16 oz. at Bridgnorth. Cheese is sold by the cwt., which, at Shrewsbury, means 12lbs., and 113lbs at Bridgnorth. Coals are sold by the ton, which is 20 cwt. of 112lbs. at some pits, and 120lbs. at others: the stack is now rarely used; it was a measure of four feet square, and would sometimes weigh 25 cwt. Hay is sold by the ton, of 20 cwt. of 112lbs. Home-made linen cloth is sold by the ell, which measures a yard and a half; and it is added, that the acre is the statute acre. That the workman's rood in digging is eight yards square; but in hedging eight yards in length.

It is suggested, too, that there is an error in the standard measure, that in the Exchequer not agreeing with the requisitions of the 13 Will. III. c. 5. By which statute, the bushel is ordered to be 18 $\frac{1}{4}$ inches round, and 8 deep; it would consequently contain

Cubic inches	-	-	-	-	2150
That in the Exchequer contains	-	-	-	-	2124
Eight of the standard gallons	-	-	-	-	2168
Thirty-two ditto quarts	-	-	-	-	2240
Sixty-four ditto pints	-	-	-	-	2027

That the difference between the bushel and 32 of the quarts is, therefore, 116 cubic inches, or nearly three pints and a half.

It is stated, too, that in the northern part of the North Riding of Yorkshire, the customary bushel exceeds that of the Winchester, by full two quarts; but nearer to the southern extremity, seldom by more than one: the bushel of some individuals in the Riding is still larger, measuring about 10 *per cent.* more than the statute requires.

And further, that a stone of wool in York market is sixteen pounds, and four ounces in each stone are allowed for draught; that is, for the draught of each fleece, the wool-buyers being empowered by act of parliament to weigh each fleece *separately*, if they like. That at Ripon market,

a stone of wool is 16 pounds 12 ounces. And a stone of wool in the Western Moorlands is 17 $\frac{1}{2}$ pounds; the half pound, the writer apprehends, is for draught, as in York market.

But that at Darlington, where the wool grown about Richmond in that district is chiefly fold, the stone is 18 pounds. And that in the Eastern Moorlands, the weights used by individuals vary up to 19 pounds to the stone.

That the pound of butter in the Riding varies from 16 to 24 ounces. But that a stone of all other commodities throughout the whole of it is 14 pounds.

In Cheshire, though the variety in the weights and measures is very considerable, it is less on the whole than in some other parts of the country.

The weights in this district are usually the avoirdupois 112lbs. to the hundred weight. Some articles are sold by what is called the long hundred of 120lbs. Cheese is one of these. Hay, too, is generally there sold by the cwt. of 120lbs.

Butter, in most parts of the county, is disposed of by the pound weighing 18 ounces. In some places it is sold in lumps, made up in moulds of different forms, called dishes, or half dishes. These weigh 24 or 12 ounces each.

Potatoes are usually disposed of by the bushel weighing 90 pounds.

Wheat by the bushel weighing either 70 or 75 pounds.

Oats by the bushel weighing from 45 to 50 pounds, as the price and bargain may be.

Oatmeal by the load weighing 240 pounds.

Barley is sometimes sold by the bushel of 60 pounds, and sometimes by the measure of 38 quarts.

Malt by the measure of 32 or 36 quarts.

Land was formerly very generally measured there by what is called the Cheshire acre, containing 10,240 square yards; and this measure still continues to be used to a certain extent, particularly in the northern part of the county. The statute acre is now, however, it is said, in much more general use.

A rood of land is 64 yards. A rood of hedging, ditching, and other such operations, eight yards in length. And a rood of marl is 62 cubic yards.

In the Lancashire Report on Agriculture, it is observed, that the rod is of no less than six different lengths in different parts of the county; namely, the statute, or 5 $\frac{1}{2}$ yards, 6, 6 $\frac{1}{2}$, 7, 7 $\frac{1}{2}$, and 8 yards, to the rod, pole, or perch: and that the measures are equally variable. At Lancaster a load of wheat, beans, and peas, is four and a half bushels (Winchester); barley, six Winchester bushels; oats, seven and a half Winchester bushels: they have also a measure called a *windle*, which is equal to three Winchester bushels. But that wheat has been sold lately by the weight of 280lbs.

That at Ulverstone, a load of wheat is four and a half Winchester bushels; oats, six Winchester bushels. And that at Manchester, a load of wheat is sixteen score; a load of oats, nine Winchester bushels; a load of beans, five Winchester bushels; a load of potatoes, twelve score and twelve pounds, washed; unwashed, thirteen score. That Liverpool town's bushel is 34 $\frac{1}{2}$ quarts for oats, barley, and beans, making exactly 36 quarts Winchester, or one-eighth more than a Winchester bushel, and by the custom of trade, one given in at every score, or twenty-one bushels; of late, wheat, barley, and oats, have been sold by weight, but never yet beans; wheat, 70lbs. to the bushel; barley, 60lbs.; and oats, 45lbs.: and probably this mode by weight is the fairest for both a buyer and seller; for, besides the difficulty of getting a true standard bushel or measure, the dexterity

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of corn-measures is such, that it is asserted they can gain either to the buyer or seller from 10 to 20 per cent. in different modes of measurement; that 5 per cent. can be obtained by this practice, by even bunglers in the business: this is an enormous profit, and the unfairness of such practices merits the severest reprehension.

That at Preston the windle of wheat, beans, and barley, is three and a half Winchester bushels; but of late 220lbs. have been reckoned a windle of wheat: they have also a measure there called a peck, which is twenty-eight quarts, four of which are called a windle.

In respect to weights, there are three different ones expressed under the general term hundred weight; namely, 100lbs., 112lbs., and 120lbs. The stone, too, varies. In Liverpool, 20lbs. are the weight allowed for the several articles under that denomination, as beef, hay, straw, &c.; and probably all the articles produced from land. And butter is required to weigh 18 ounces avoirdupois, or it may be seized by the magistrates.

At Lancaster, and the neighbourhood, they have several different weights, as the Lancaster peck, of twenty-four quarts; the common peck, of sixteen quarts; the half Winchester; the windle, of three and a half bushels; the met, of fifty-six quarts; the ackendale, or ackentyde, the eighth part of the above, or seven quarts, and the measure of four quarts. The load of malt is six bushels.

Butter eighteen ounces to the pound; other articles fifteen.

There are also different local variations in many articles.

In Westmoreland, the pound consists of twelve, sixteen, eighteen, or twenty-one ounces; and the stone of fourteen, sixteen, or twenty pounds. There is also a Winchester bushel, a customary bushel equal to three of these, a bushel of two bushels for the sale of potatoes near Appleby, and one of two and a half for that of barley. Rye is sold by the boll of two bushels, and potatoes by the load of four bushels and a half heaped; or more generally a bag, which holds seven and a half bushels, is filled and sold for a load of potatoes.

There is the statute acre, too, of 4840 square yards, the customary acre of 6760 raised from the perch of six and a half yards, and a third acre on the borders of Lancashire, raised from the perch of seven yards, containing 7840, being the same as the Irish plantation acre.

It is remarked, likewise, in the Cumberland Report on Agriculture, that the same confusion in weights and measures prevails there, as in many other parts of the kingdom.

That a Winchester bushel is thirty-two quarts; a Carlisle bushel, ninety-six quarts; and a Penrith bushel, sixty-four quarts, for wheat and rye; and eighty quarts, for barley, oats, and potatoes.

That a stone of tallow, wool, yarn, or hay, is 16lbs.; and a stone of butcher's meat 14lbs., but in many places 16lbs.

That the pound is sixteen ounces, by which butter and various other articles are weighed.

The writers of the Account of Agriculture for Northumberland, state that their weights and measures are in a sad state of confusion; a pound, a stone, a bushel, and a boll, are rarely the same in different markets, and frequently vary in the same market for different articles.

At Newcastle.

4 Beatments	make	1 Peck		
2 Pecks	-	-	-	1 Kenning
2 Kennings	-	-	-	1 Bushel, Winchester
2 Bushels	-	-	-	1 Boll.

At Hexham, with Rye and Peas.

4 Quarts	make	1 Forpitt		
4 Forpits	-	-	-	1 Peck
4 Pecks	-	-	-	1 Bushel
2 Bushels	-	-	-	1 Boll = 4 Winchester bushels.

For Oats and Barley.

4 Quarts	make	1 Forpitt		
5 Forpits	-	-	-	1 Peck
4 Pecks	-	-	-	1 Bushel
2 Bushels	-	-	-	1 Boll = 5 bushels Winchester.

At Alnwick.

3 Quarts	make	1 Forpitt		
4 Forpits	-	-	-	1 Peck
3 Pecks	-	-	-	1 Bushel, Winchester
2 Bushels	-	-	-	1 Boll of wheat
6 Bushels	-	-	-	1 Boll of barley or oats.

At Wooler.

4 Quarts	make	1 Forpitt		
3 Forpits	-	-	-	1 Peck
3 Pecks	-	-	-	1 Bushel
6 Bushels	-	-	-	1 Boll.

That a stone of wool in some parts is 24lbs.; in others, 18lbs.; and a stone of every other article is 14lbs.

As the weights and measures made use of in Scotland differ very materially from those employed in England, it may, of course, not be useless to give a cursory view of them under the present head. It has been observed by Mr. Somerville, in his Account of the Agriculture of East Lothian, that land is measured by the Scotch acre, which is to the English acre very nearly in the proportion of five to four.

That the boll is the denomination of corn measure always used, but the contents vary according to the species of grain measured. But that there are uniformly four firlots in the boll of all grain; but the firlot differs in size in the proportion of 21, 25, to 31. Wheat, rye, beans, and peas, are sold by the small firlot; malt, barley, and oats, are sold by the large one. Four small firlots are 4.087276 Winchester bushels; four large ones are 5.96263 bushels Winchester. The boll of wheat then is a small fraction more than half a quarter; and the boll of barley, a fraction less than three-fourths of a quarter. But this calculation applies, it must be remembered, to the Linlithgow boll, which is accounted the standard measure of Scotland: the measure actually used in East Lothian is somewhat larger.

In the Mid-Lothian Report on Agriculture, it is stated, that flour, pot-barley, groceries, iron, and ropes, are bought and sold there, by what is termed English weight, being 16 oz. to the pound, and 16lbs. to the stone. But that butcher's meat, oatmeal, and flax, are bought and sold by what is called Dutch weight, of which the proportion to the English is as 17½ to 16.

That wool, hay, and butter, are bought and sold by trone weight, of which the proportion is to the English, as 22 to 16. That other articles are bought and sold by either of these weights, as it may happen.

But that in long measure the inch is the root, of which 12 go to the foot, and 37 to the Scotch yard.

And that land is measured by a chain 24 yards in length, or 74 feet, divided into 100 links, of 8.888 inches each in length; 10 square chains make an acre, or 5760 square yards Scotch, equal to 6084.444 English; and as the

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the English acre consists of 4840 square yards, hence the proportion that the Scotch acre bears to the English is, with a small fraction more, as 5 to 4, as seen above.

That in liquid measure the *pint* is the root, containing 103.404 cubic inches; the half and quarter in proportion.

That the Linlithgow wheat firloft, the only standard measure for that grain in Scotland, contains $21\frac{1}{4}$ pints; hence in cubic inches 2197.34. The Winchester bushel, in like manner the English standard, contains 2150.42 cubic inches; hence the Scotch wheat firloft is about $2\frac{1}{7}$ per cent. greater than the English bushel.

And the Linlithgow barley measure, which is likewise the standard, contains 31 pints, or 3205.54 cubic inches; hence $5\frac{2}{3}$ bushels are very nearly equal to the Scotch boll of 4 firlofts.

That straw is fold by tale, 40 windlens to a kemple, generally from 14 to 16 stone trone weight.

It is noticed, that in East Lothian, meal is fold by the peck of eight pounds Amsterdam weight; and that the boll of meal contains sixteen pecks or eight stones.

It is stated in the Clydesdale Report on Agriculture, that in the dry measure, used in the sale of grain of all kinds, a boll contains four firlofts, a firloft four pecks, and a peck four forpits or lippies; 16 bolls make a chaldier. The firloft used to measure barley and oats, is almost one-half larger than the firloft for measuring wheat, beans, peas, &c. That both these measures are about one-sixteenth larger than the Linlithgow standards of the same denominations. But for more than thirty years past, wheat has been bought and sold by the Linlithgow standard, which is now attempted to be introduced for other grains.

That in the lower parts of the county potatoes have been measured, for these forty years, with a dish of the shape of a cask, the peck measure holding fifteen Scotch pints; its weight, full of potatoes recently dug, is 43lbs. avoirdupois. In the higher parts of the county potatoes are sold by the barley measure.

That the peck, or *sheek*, for measuring pears and apples, holds about eighteen pints. The confusion occasioned by the irregularity of weights and measures, is too obvious, the writer says, to require any comment.

In the Argyshire Agricultural Report, it is said that at Inverary the boll of meal is eight stone Scotch troy, or Dutch 17 $\frac{1}{2}$ lbs. avoirdupois to the stone. At Campbelton it is ten stone, of the same weight; or sixteen pecks of 10lbs. Scotch troy, or 10lbs. 15 oz. avoirdupois each.

That in some parts of the Knapdale and Lorn, the boll is nine stone. That in the first of the above places, oats, barley, and malt, are measured by a firloft of 3438.183 cubic inches; equal to one firloft, two pints, one mutchkin, Scotch standard measure, which makes the boll (of four firlofts) 7.258 per cent. better than the Scotch standard measure, and equal to six bushels, one peck, nine pints, 10.2 cubic inches, English standard measure.

And that in Kintyre, oats, barley, or bear and malt, were, for time immemorial, sold by a heaped peck, of which the standard lay with the dean of Guild in Campbelton. Of this measure, seventeen pecks made, and still make, the Kintyre boll from August to Patrickmas, and only sixteen from that date to the new crop; and the divisions of the boll are regulated by the same proportions. But from the inconvenience of measuring by the heaped peck, it has been

converted into the striked one containing the same quantity; and this new striked peck committed to the dean of Guild, has been since the standard of the district. The dimensions of it are twelve English inches diameter, equally wide throughout, and ten and a tenth English inches deep. The contents of it in cubic inches are 1142.28576, equal to eleven Scotch pints, and a very little more than two-thirds of a gill, which makes the Kintyre boll 19418.85792 cubic inches, before Patrickmas, and 18276.57216 after it. A lippie more, or $\frac{1}{4}$ th of a boll, for town dues, is given with every boll delivered in Campbelton. The first is equal to nine Winchester bushels, and 65.03112 cubic inches, (about $\frac{3}{7}$ of a bushel) and equal to one boll eight pecks, 1.61788 lippie, Linlithgow standard measure. The latter is equal to eight and a half Winchester bushels, excepting 2.0394 cubic inches, and to one boll six pecks, $3\frac{2}{3}$ lippies Linlithgow. The Winchester bushel contains 2150.42 cubic inches. The Linlithgow boll standard measure 12822.096.

That at Inverary, the peck of potatoes contains fourteen pints and one mutchkin, ale measure. At Campbelton, it contains about nine English wine gallons, and is given heaped; and generally weighs about 56lbs. avoirdupois.

But that beans and peas are sold in Kintyre by the old peck striked, or by a measure one-third less than that for oats and bear. Lineal and liquid measures are the same with the Scotch standards. Butter, cheese, tallow, hay, wool, and lint, are sold by the stone of 24lbs. avoirdupois. Butcher's meat by the pound of twenty-four ounces avoirdupois at Inverary, and of sixteen ounces at Campbelton. The herring-barrel contains thirty-two English gallons of wine measure, or 67.28 customary ale pints of 109.866 cubic inches each.

These facts and statements sufficiently shew the necessity of some regulation being speedily adopted of adjusting weights and measures to some simple standard, both in this and the northern parts of the kingdom.

The table of weights constructed by lord Somerville, and introduced below, may be useful to the stock-farmer and grazier in most situations.

TABLE for the Equalization of different Weights.

Scores.	Stones, at 14lbs.		Stones, at 8lbs.		Scotch Stones 16lbs.		Hundred, 112lbs.	
	St.	lbs.	St.	lbs.	St.	lbs.	Cwt.	qrs. lbs.
20 equal	28	8	50	0	25	0	3	2 8
25 —	35	10	62	4	31	2	4	1 24
30 —	42	12	75	0	37	4	5	1 12
35 —	50	0	87	4	43	6	6	1 0
40 —	57	2	100	0	50	0	7	0 16
45 —	64	4	112	4	56	2	8	0 4
50 —	71	6	125	0	62	4	8	3 20
55 —	78	8	137	4	68	6	9	3 8
60 —	85	10	150	0	75	0	10	2 24
65 —	92	12	162	4	81	2	11	2 12
70 —	100	0	175	0	87	4	12	2 0
75 —	107	2	187	4	93	6	13	1 16
80 —	114	4	200	0	100	0	14	1 4

WEIGHTS.

TABLE OF PRICES.

Scores at	$3\frac{1}{4}d.$			$3\frac{1}{2}d.$			$3\frac{3}{4}d.$			$4d.$			$4\frac{1}{4}d.$			$4\frac{1}{2}d.$			$4\frac{3}{4}d.$			$5d.$			Difference.					
	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>
1	0	5	5	0	5	10	0	6	3	0	6	8	0	7	1	0	7	6	0	7	11	0	8	4	0	0	5	0	0	5
2	0	10	10	0	11	8	0	12	6	0	13	4	0	14	2	0	15	0	0	15	10	0	16	8	0	0	10	0	0	10
3	0	16	3	0	17	6	0	18	9	1	0	0	1	1	3	1	2	6	1	3	9	1	5	0	0	1	3	0	1	3
4	1	1	8	1	3	4	1	5	0	1	6	8	1	8	4	1	10	0	1	11	8	1	13	4	0	1	8	0	1	8
5	1	7	1	1	9	2	1	11	3	1	13	4	1	15	5	1	17	6	1	19	7	2	1	8	0	2	1	0	2	1
20	5	8	4	5	16	8	6	5	0	6	13	4	7	1	8	7	10	0	7	18	4	8	6	8	0	8	4	0	8	4
25	6	15	5	7	5	10	7	16	3	8	6	8	8	17	1	9	7	6	9	17	11	10	8	4	0	10	5	0	10	5
30	8	2	6	8	15	0	9	7	6	10	0	0	10	12	6	11	5	0	11	17	6	12	10	0	0	12	6	0	12	6
35	9	9	7	10	4	2	10	18	9	11	13	4	12	7	11	13	2	6	13	17	1	14	11	8	0	14	7	0	14	7
40	10	16	8	11	13	4	12	10	0	13	6	8	14	3	4	15	0	0	15	16	8	16	13	4	0	16	8	0	16	8
45	12	3	9	13	2	6	14	1	3	15	0	0	15	18	9	16	17	6	17	16	3	18	15	0	0	18	9	0	18	9
50	13	10	10	14	11	8	15	12	6	16	13	4	17	14	2	18	15	0	19	15	10	20	16	8	1	0	10	1	0	10
55	14	17	11	16	0	10	17	3	9	18	6	8	19	9	7	20	12	6	21	15	5	22	18	4	1	2	11	1	2	11
60	16	5	0	17	10	0	18	15	0	20	0	0	21	5	0	22	10	0	23	15	0	25	0	0	1	5	0	1	5	0
65	17	12	1	18	19	2	20	6	3	21	13	4	23	0	5	24	7	6	25	14	7	27	1	8	1	7	1	1	7	1
70	18	19	2	20	8	4	21	17	6	23	6	8	24	15	10	26	5	0	27	14	2	29	3	4	1	9	2	1	9	2
75	20	6	3	21	17	6	23	8	9	25	0	0	26	11	3	28	2	6	29	13	9	31	5	0	1	11	3	1	11	3
80	21	13	4	23	6	8	25	0	0	26	13	4	28	6	8	30	0	0	31	13	4	33	6	8	1	13	4	1	13	4
85	23	0	5	24	15	10	26	11	8	28	6	8	30	2	1	31	17	6	33	12	11	35	8	4	1	15	5	1	15	5
90	24	7	6	26	5	0	28	2	6	30	0	0	31	17	6	33	15	0	35	12	6	37	10	0	1	17	6	1	17	6
95	25	14	7	27	14	2	29	13	9	31	13	4	33	12	11	35	12	6	37	12	1	39	11	8	1	19	7	1	19	7
100	27	1	8	29	3	4	31	5	0	33	6	8	35	8	4	37	10	0	39	11	8	41	13	4	2	1	8	2	1	8

TABLE—Continued.

Scores at	$5\frac{1}{4}d.$			$5\frac{1}{2}d.$			$5\frac{3}{4}d.$			$6d.$			$6\frac{1}{4}d.$			$6\frac{1}{2}d.$			$6\frac{3}{4}d.$			$7d.$			Difference.					
	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>
1	0	8	9	0	9	2	0	9	7	0	10	0	0	10	5	0	10	10	0	11	3	0	11	8	0	0	5	0	0	5
2	0	17	6	0	18	4	0	19	2	1	0	0	1	0	10	1	1	8	1	2	6	1	3	4	0	0	10	0	0	10
3	1	6	3	1	7	6	1	8	9	1	10	0	1	11	3	1	12	6	1	13	9	1	15	0	0	1	3	0	1	3
4	1	15	0	1	16	8	1	18	4	2	0	0	2	1	8	2	3	4	2	5	0	2	6	8	0	1	8	0	1	8
5	2	3	9	2	5	10	2	7	11	2	10	0	2	12	1	2	14	2	2	16	3	2	18	4	0	2	1	0	2	1
20	8	15	0	9	3	4	9	11	8	10	0	0	10	8	4	10	16	8	11	5	0	11	13	4	0	8	4	0	8	4
25	10	18	9	11	9	2	11	19	7	12	10	0	13	0	5	13	10	10	14	1	3	14	11	8	0	10	5	0	10	5
30	13	2	6	13	15	0	14	7	6	15	0	0	15	12	6	16	5	0	16	17	6	17	10	0	0	12	6	0	12	6
35	15	6	3	16	0	10	16	15	5	17	10	0	18	4	7	18	19	2	19	13	9	20	1	4	0	14	7	0	14	7
40	17	10	0	18	6	8	19	3	4	20	0	0	20	16	8	21	13	4	22	10	0	23	6	8	0	16	8	0	16	8
45	19	13	9	20	12	6	21	11	3	22	10	0	23	8	9	24	7	6	25	6	3	26	5	0	0	18	9	0	18	9
50	21	17	6	22	18	4	23	19	2	25	0	0	26	0	10	27	1	8	28	2	6	29	3	4	1	0	10	1	0	10
55	24	1	3	25	4	2	26	7	1	27	10	0	28	12	11	29	15	10	30	18	9	32	1	8	1	2	11	1	2	11
60	26	5	0	27	10	0	28	15	0	30	0	0	31	5	0	32	10	0	33	15	0	35	0	0	1	5	0	1	5	0
65	28	8	9	29	15	10	31	2	11	32	10	0	33	17	1	35	4	2	36	11	3	37	18	4	1	7	1	1	7	1
70	30	12	6	32	1	8	33	10	10	35	0	0	36	9	2	37	18	4	39	7	6	40	16	8	1	9	2	1	9	2
75	32	16	3	34	7	6	35	18	9	37	10	0	39	1	3	40	12	6	42	3	9	43	15	0	1	11	3	1	11	3
80	35	0	0	36	13	4	38	6	8	40	0	0	41	13	4	43	6	8	45	0	9	46	13	4	1	13	4	1	13	4
85	37	3	9	38	19	2	40	14	7	42	10	0	44	5	5	46	0	10	47	16	3	49	11	8	1	15	5	1	15	5
90	39	7	6	41	5	0	43	2	6	45	0	0	46	15	6	48	13	0	50	12	6	52	10	0	1	17	6	1	17	6
95	41	11	3	43	10	10	45	10	5	47	10	0	49	9	7	51	9	2	53	8	9	53	8	4	1	19	7	1	19	7
100	43	15	0	45	16	8	47	18	4	50	0	0	52	1	8	54	3	4	56	5	0	58	6	8	2	1	8	2	1	8

WEIGHT, *Pondus*, in *Mechanics*, is any thing to be raised, sustained, or moved by a machine; or any thing that in any manner resists the motion to be produced. See **MOTION**, &c.

In all machines, there is a natural ratio between the weight and the moving power. If the weight be increased, the power must be so too; that is, the wheels, &c. are to be multiplied, and so the time increased, or the velocity diminished.

“The centre of gravity *F*, (*Plate XL. Mechanics, fig. 6.*) of a body *I H*, together with the weight of the body, being given; to determine the point *M*, in which, lying on a horizontal plane, a given weight *G*, hung in *L*, cannot remove the body *I H* out of its horizontal situation.”

Conceive a weight hung in the centre of gravity *F*, equal to the weight of the whole body *I H*, and find the common centre of gravity *M*, of that and the given weight *G*. If the point *M* be laid on the horizontal plane, the weight *G* will not be able to move the body *H I* out of its place.

“The centre of gravity *C* (*fig. 7.*) of a body *A B*, together with its weight *G*, being given; to determine the points *L* and *M*, wherein props *M N* and *L O* are to be placed, that each may bear any given proportion of the weight.”

In the horizontal line *A B*, passing through the centre of gravity *C*, assume the right lines *M C* and *C L* in the given ratio. Props, then, *M N*, *L O*, placed in these points, will be pressed in the given ratio.

Hence, if in the points *M*, *L*, in lieu of props, you place the shoulders or arms of porters, &c. they will be able to bear the burden alike; if their shares be proportioned to their strengths. Thus we have a way of distributing a burden in any given ratio.

WEIGHTS, *Gros, Neat, Penny, Assay of, Ancel.* See the several articles.

WEIGHT of the Atmosphere. See **ATMOSPHERE**.

WEIGHT of the Air, is equal to the elasticity thereof.

To find the *Weight of a Cubic Inch of Air*.—Weigh a round glass vessel full of common air, very accurately; then exhaust the air out of it; weigh the exhausted vessel, and subtract the latter weight from the former, the remainder is the weight of the air exhausted.

Find, then, the content of the vessel by the laws of measuring; and the ratio of the remaining air to the primitive air. This done, the bulk of the remaining air is found by the rule of three; which being subtracted from the capacity of the vessel, the remainder will be the bulk of air extracted. Or, if the air-pump be very tight, and the exhaustion continued as long as any air is got out, the remaining air will be so small, that it may be very safely neglected, and the content of the vessel taken for the bulk of the exhausted air.

Having, therefore, the weight and bulk of the whole exhausted air, the weight of one cubic inch is easily had by the rule of three.

This method was first used by Otto Guericke, and afterwards by Burcher de Volder, who gives us the following particulars in his experiment. 1. That the weight of the glass spherical vessel he made use of, full of common air, was 7 lbs. 1 oz. 2 drs. 48 grs.; when exhausted of air, 7 lbs. 1 oz. 1 dr. 31 grs.; and when full of water, 16 lbs. 12 oz. 7 drs. 14 grs. The weight of the air, therefore, was 1 dr. 17 grs. or 77 grs.; the weight of the water 9 lbs. 11 oz. 5 drs. 43 grs. or 74743 grs. Consequently, the ratio of the specific gravity between water and air is 74743 : 77 :: 970 $\frac{5}{7}$: 1. Now, De Volder having found a cubic foot of water to weigh 64 lbs., by inferring, as 970 is to 1, so is 64 lbs. to a

fourth proportional, deduced by the rule of three, the weight of a cubic foot of air, viz. 1 oz. 27 grs. or 507 grs. nearly. Wolfii Elem. tom. ii. p. 291.

From other later experiments accurately made with the hydrostatical balance, a cubic inch of air appears to be equal to two-sevenths of a grain, and therefore a cubic foot equal to 493 $\frac{5}{7}$ troy grains. There are various ways of estimating the weight of the air; for which, see **AIR**, **ATMOSPHERE**, **BAROMETER**, **Specific GRAVITY**, &c.

It may be easily determined by fitting a brass cap, with a valve tied over it, to the mouth of a thin bottle or Florence flask, whose contents are exactly known, and screwing the neck of this cap into the hole of the plate of the air-pump; then, having exhausted the flask of its air and taken it off from the pump, suspend it at one end of a balance, and nicely counterpoise it by weights in the scale at the other end: when this is done, raise up the valve with a pin, and the air will rush into the flask, and cause it to descend. When it is full of air, put grains into the scale at the other end to restore the equilibrium; and if the flask holds exactly a quart, it will be found, that 17 grs. will be sufficient for this purpose, when the quicksilver stands at 29 $\frac{1}{2}$ inches in the barometer; and this shews, that when the air is at a mean ratio of density, a quart of it weighs 17 grs.; and consequently a gallon weighs 68 grs.: i. e. 231 cubic inches of air are equal in weight to 68 grs., and 1728 cubic inches, or a cubic foot of air, weighs 509 $\frac{5}{7}$ grs.; and as a cubic foot of water weighs about 437702 troy grains, the specific gravity of water will appear to be more than 850 times that of air. See **AIR**.

The weight of *sea-water* is different in different climates. Mr. Boyle having furnished a learned physician, going on a voyage to America, with an hydrostatical balance, and recommended him to observe, from time to time, the difference of weight he might meet withal; this account was returned him: that the sea-water increased in weight, the nearer he came to the line, till he arrived at a certain degree of latitude, as he remembers, about the 30th; beyond which, it retained the same specific weight, till he came to Barbadoes. Philof. Transf. N^o 18.

The weight of a cubical inch of good brandy, rum, or other proof spirits, is 235.7 grs.; therefore, if a true inch cube of any metal weighs 235.7 grs. less in spirits than in air, it shews the spirits are proof; if it loses less of its aerial weight in spirits, they are above proof; if it loses more, they are under: for the better the spirits are, they are the lighter; and the worse, the heavier.

As all bodies expand with heat and contract with cold, in different degrees, the specific gravities of bodies are not precisely the same in summer as in winter. It has been found, that a cubic inch of good brandy is 10 grs. heavier in winter than in summer; as much spirit of nitre, 20 grs.; vinegar, 6 grs.; and spring-water, 3 grs. Hence it is most profitable to buy spirits in winter, and sell them in summer, since they are always bought and sold by measure. It has been found, that 32 gallons of spirits in winter will make 33 in summer. Ferguson's Lect. p. 98. 4to. See **Specific GRAVITY**, and **HYDROMETER**.

WEIGHT of the Human Body. It is to be observed, that the heat and dryness of the air both lessen the weight of the body, and the cold and moisture of the air both increase this weight. See **MOISTURE**.

Much sleep, much food, and little exercise, are the principal things which increase the weight of the body, and make animals grow fat. Consequently, if the weight of the body be too great for good and uninterrupted health, it may be lessened by diminishing sleep and food, and by increasing

creasing exercise. On the contrary, if the weight of the body be too little for good health, it may be increased by adding to food and sleep, and by lessening exercise; and the food must be increased chiefly by increasing drink and liquid nourishment. For the discharges are commonly less from drink and liquid nourishment, than from dry and solid food.

There is but one weight under which a body can enjoy the best and uninterrupted health, and that weight must be such, that perspiration and urine may be nearly equal at all seasons of the year; for by this means the body will be uniformly drained of its moisture: the inward parts by urine, and the more superficial parts by perspiration, without any irregular and unnatural discharges, and its moving weight will continue nearly the same at all seasons of the year. Dr. Bryan Robison thinks this weight may be settled by his observations in his Treatise on Food and Discharges of Human Bodies.

A quick increase of weight in human bodies often produces distempers; the best way to prevent this increase is either by fasting or exercise. But amidst a variety of disturbing causes, nothing so effectually prevents such an increase of weight as a very exact and regular diet, which may prevent the discharges from running into irregularities and disproportions to one another. See Dr. Bryan Robison of the Food and Discharges of Human Bodies, p. 82. seq.

Men, and other animals of extraordinary weight, are often recorded in the writings of the learned. See Phil. Trans. N^o 479, p. 102.

WEIGHT, Athletic, in the *Animal Economy*, that weight of the body under which an animal has the greatest strength and activity. Dr. Robison thinks this happens when the weight of the heart, and the proportion of the weight of the heart to the weight of the body, are greatest. For the strength of an animal is measured by the strength of its muscles, and the strength of the muscles is measured by the strength of the heart. Also the activity of an animal is measured by the weight of the heart, in proportion to the weight of the body.

If the weight of the body of an animal be greater than its athletic weight, it may be reduced to that weight by evacuations, dry food, and exercise. These lessen the weight of the body by wasting its fat, and lessening its liver, and they increase the weight of the heart, by increasing the quantity and motion of the blood; so that by lessening the weight of the body, and by increasing that of the heart, they will soon reduce the animal to its athletic weight. Thus a game cock, in ten days, is reduced to its athletic weight, and prepared for fighting. If the food which, with the evacuations and exercise, reduced the cock to its athletic weight in ten days, be continued any longer, the cock will lose his strength and activity.

It is known by experience, that a cock cannot stand above twenty-four hours at his athletic weight, and that he has even changed for the worse in twelve hours. When he is in the best condition, his head is of a glowing red colour, his neck thick, and his thigh thick and firm; the day after, his complexion is less glowing, his neck thinner, and his thigh softer; and the third day his thigh will be very soft and flaccid. Four game cocks, reduced to their athletic weight, were killed, and found to be very full of blood, with large hearts, large muscles, and no fat.

It is to be observed, that the athletic weight of an animal is a very dangerous weight. Fevers and apoplexies are the disorders which commonly happen to animals under or near the athletic weights. Hence, horses fed upon dry food are

much more subject to fevers and apoplexies than horses fed upon grafs. Robinson's Dissertation, p. 117, &c.

WEIGHTS, Sessions for. See SESSIONS.

WEIGHT, Live and Dead, of Animals, in *Agriculture and Rural Economy*, the differences between their living and dead weights as affecting their goodness and value for the purpose of the breeder and feeder or fatterer. But few correct trials have yet been made in the view of determining this very important point or particular. It would seem, however, from the little that has been done on the subject, that those sorts of live-stock that have the best forms, and the least weight in the different offal parts, are the most valuable and beneficial to the stock master and farmer.

In neat cattle stock the difference or loss in this way is somewhere about a fourth, but the most in those breeds which are the least correct in their forms or shapes. In some unimproved breeds it has been found a good deal more, while in those which have been greatly improved rather less. In calves it will mostly be from a third to a fourth.

In the good Herefords, and some of the best long horn or Lancashire sorts, these proportions have been found on trial to be very nearly correct, both in the grown beasts and the calves.

In sheep stock, too, the same principle, for the most part, holds good, those having the least difference or loss in this way that are the best in their forms.

In trials with the South Down breed of sheep, as stated in the Corrected Report on the Agriculture of the County of Suffex, the proportions of the live and dead weight are these:

	lbs.
Live weight of the sheep - - -	192
Dead weight next day of carcase - -	125

Weight of Offal.

	lbs.	oz.
Blood - - - - -	6	0
Entrails - - - - -	11	0
Caul - - - - -	16	4
Gut fat - - - - -	5	0
Head and pluck - - - - -	8	12
Pelt - - - - -	15	12

In an average specimen of a wether of the same breed:

	lbs.
Live weight of the sheep - - -	133
Dead weight the day after - - -	73

Weight of Offal.

	lbs.
Blood - - - - -	4
Tallow - - - - -	10
Entrails - - - - -	14
Skin and feet - - - - -	16
Head and pluck - - - - -	9

In one of general Murray's breed of the same kind:

	lbs.
Live weight - - - - -	129
Dead weight - - - - -	62

Weight of Offal.

	lbs.
Tallow - - - - -	6

It is remarked that the lightness of the offal, such as the head, horns, feet, entrails, pluck, blood, pelt, &c. is the circumstance which characterizes a good sheep; and it is said,

faid, that Dishley wethers well fattened are in the proportion of one ounce of bone to a pound of flesh.

That the offal, in the fat wether of the South Down breed first flated, was but a fifth part and a fraction of the live weight, as below :

	lbs.	oz.
Live weight - - - -	192	0
Offal - - - - -	42	0
Carcafe - - - - -	125	0
Fat - - - - -	21	4
Loft by killing - - -	3	12
	192	0

Some useful information, which has a tendency to elucidate the point concerning the proportion between the live and dead weight of some different breeds of sheep, has been given under the head sheep. See SHEEP, PELT, and TALLOW.

In good pig flock the difference in the proportion between the live and dead weight of the animals, or the loss of weight that is sustained by the farmer, will be found probably to be rather less than a fourth in the better breeds, and rather more than that in those which are inferior in their qualities. The best breeds of pigs have by much the least loss in this way, and they have advantages in other respects. See SWINE.

These facts and statements tend to shew the advantages which the farmer has in keeping good live-stock of all kinds.

WEIGHTON, MARKET, in *Geography*, a small market-town in the Holme-beacon division of Harthill wapentake, East Riding of the county of York, England, is situated on a little river called Foulness, in the high road between York and Hull, at the distance of 19 miles E.S.E. from York, and 192 miles N. by W. from London. Some antiquaries considered this place the Roman station, Dolgovitia, till Drake, with great appearance of probability, assigned that station to the village of Londesburgh, nearly three miles north of Weighton. This town consists of one long street, intersected by a few smaller: till within the last thirty years, the houses were in general low and mean, and covered with thatch; but since that period, a number of respectable buildings have been erected, and considerable improvements have been made. A weekly market is held on Wednesdays, when a great quantity of corn is often sold, though but little is exposed, being chiefly disposed of by sample. Two fairs are held annually for horses, cattle, and particularly for sheep, and cheese. The trade of the town has been considerably increased by means of a canal from the Humber; whereby coals and other articles are brought hither, and the barges return laden with grain. By the population return of the year 1811, the inhabitants of this town are enumerated at 1508; the number of houses as 239. The church is an ancient massive edifice; it formerly had a wooden spire, which has been recently taken down, and a considerable addition made to the height of the tower; the interior of the church has also been greatly improved, and furnished with an additional gallery. A meeting-house for Methodists has lately been erected. There is no endowed school in the parish. About two miles east of Weighton is the brow of the Yorkshire wolds, whence very extensive views are obtained.—Beauties of England and Wales, vol. xvi. Yorkshire, by J. Bigland, 1812. Drake's Eboracum, or the History and Antiquities of York, fol. 1736.

WEIGSDORF, a town of Bohemia, in the circle of Boleslaw; 8 miles N.N.E. of Krotttau.

WEIGSTOTTEN, a town of Austria; 6 miles N.W. of Steyr.

WEIKENDORFF, a town of Austria; 8 miles S. of Zisterdorf.

WEIKERSTORF, a town of Austria; 4 miles S.W. of Sonneberg.

WEIKERTSCHLAG, a town of Austria; 8 miles W. of Drofendorf.

WEIL, a town of Wurtemberg, on the Wirm. This was an imperial town, till in 1802 it was given to the duke of Wurtemberg, by whose dominions it was surrounded; 10 miles W.S.W. of Stuttgart. N. lat. 48° 48'. E. long. 8° 50'.

WEILACH, a river of Bavaria, which runs into the Par, near Schrobenhausen.

WEILBACH, a river of Germany, which runs into the Lahn, 2 miles S. of Weilburg.

WEILBURG, a town of Germany, which gives name to a county belonging to the house of Nassau, hence called Nassau Weilburg, situated on an eminence on the Lahn, over which it has a bridge of stone. The prince's palace here contains some very elegant apartments; with a fine garden belonging to it, and a chapel answerable to the whole. All the roads near the town lie in a direct line, and are planted on each side with a row of trees. In the neighbourhood is a large menagerie; 9 miles W. of Wetzlar. N. lat. 50° 26'. E. long. 8° 18'.

WEILE, or WEDEL, a sea-port town of Denmark, in North Jutland, situated on a bay in the Little Belt; 38 miles N.E. of Ripen. N. lat. 55° 45'. E. long. 9° 30'.

WEILHAIM, or WEILHEIM, a town of Bavaria; 26 miles S.W. of Munich. N. lat. 47° 44'. E. long. 11° 4'.

WEILHEIM, a town of Wurtemberg, on the Lauter; 20 miles N.E. of Ulm. N. lat. 48° 33'. E. long. 9° 35'.

WEILKO STRZLCZE. See STRELITZ.

WEILMUNSTER, a town of the principality of Nassau Weilburg; 5 miles S. of Weilburg.

WEILNAU, a town of Germany, in the principality of Nassau Weilburg; 13 miles S. of Weilburg.

WEILTINGEN, a town of Wurtemberg, on the Warnitz; 40 miles S.W. of Nuremberg. N. lat. 49° 3'. E. long. 10° 30'.

WEIMAR, a principality and duchy of Saxony, situated in Thuringia, on the sides of the Ilm; about 24 miles in length, and 20 in breadth, but considerable tracts are detached from the main body.—Also, a town of Saxony, and capital of a duchy of the same name, with a palace of the prince, in which the duke has a valuable library, a cabinet of medals, a museum, and a gallery of paintings; and where are kept the archives of the Ernestine line of the dukes of Saxony; 94 miles W. of Dresden. N. lat. 51° 2'. E. long. 11° 22'.

WEINBERG, a town of Austria; 4 miles S.E. of Freyftadt.—Also, a town of the principality of Anspach; 3 miles N.N.E. of Feuchtwang.

WEINFELDEN, a town of Switzerland, in the canton of Zurich, and principal place of a bailiwick, in the Thurgau; 4 miles S.W. of Constance.

WEINGARTEN, a town of the duchy of Baden; 13 miles S.S.E. of Spire. N. lat. 49° 3'. E. long. 8° 30'.

WEINGE, a town of Sweden, in the province of Halland; 12 miles S.E. of Halmstad.

WEINHAUSEN, a town of Westphalia, in the principality of Luneburg Zell; 6 miles from Zell.

WEINHEIM, a town of the duchy of Baden, situated in the Bergstrasse, and famous for its wine. The Roman Catholics, the Lutherans, and the Calvinists, have each a church; 9 miles N. of Heidelberg.

WEINITZ, or VINIZA, a town of the duchy of Carinola, on the Kulp; 10 miles E.N.E. of Gotschee.

WEINMANNIA, in *Botany*, a name which seems to have originated with Dr. Patrick Browne, who, without due attention, called it *Windmannia*. The person whom he designed to commemorate was John William Weinmann, an apothecary of Ratisbon, author of a huge botanical German work, entitled *Phytanthozaiconographia*, consisting of four thick folios, with 1025 large coloured engravings of plants. The first volume appeared in 1737, the last in 1745, after the author's decease. There is a preface to the latter by Haller. Dieterich and Bieler contributed part of the text, and there are ample indexes, in various languages. The plates are rude, and gloomily coloured. Trew, whose candour nevertheless is allowed by Haller, says, "varieties are not distinguished," in this work, "from species, the structure of the flowers is scarcely expressed, nor was the author competent to refer his plants to their true genera." Burmann began a Dutch edition, with some additions, in 1736. The book is necessarily expensive, on account of its bulk, and is rare in England. We have seldom had occasion to consult it, nor have we ever done so without disappointment.—Linn. Gen. 195. Schreb. 263. Willd. Sp. Pl. v. 2. 436. Mart. Mill. Dict. v. 4. Juss. 309. Poir. in Lamarck Dict. v. 7. 578. Lamarck Illustr. t. 313. (*Windmannia*; Browne Jam. 212.)—Class and order, *Oelandria Digynia*. Nat. Ord. akin to *Saxifraga*, Juss.; or rather, we should think, as he himself hints, to his *Rhododendra*.

Gen. Ch. *Cal.* Perianth inferior, of four ovate, spreading, permanent leaves. *Cor.* Petals four, equal, undivided, larger than the calyx. Nectary glandular, surrounding the base of the germen. *Stam.* Filaments eight, erect, thread-shaped, longer than the petals; anthers roundish, of two cells. *Pist.* Germen superior, ovate, acute; styles two, somewhat spreading, the length of the stamens, permanent; stigmas obtuse. *Peric.* Capsule elliptic-oblong, with two points, two cells, and two valves, whose inflexed margins form the double partitions. *Seeds* about eight in each cell, roundish.

Eff. Ch. Calyx of four leaves. Petals four. Capsule superior, with two beaks, two cells, and two valves with inflexed margins. *Seeds* several.

A very handsome genus of extra-European shrubs, with opposite, compound or simple leaves, accompanied by interfoliate deciduous stipulas. The flowers are small, copious, racemose, rarely paniced. *Capsules* permanent long after the seeds are shed. CUNONIA, (see that article,) appears to differ from this genus, merely by adding one-fifth to the parts of fructification, which in this case is of no avail whatever.

Sect. 1. *Leaves compound.*

1. *W. glabra.* Smooth Pinnate *Weinmannia*. Linn. Suppl. 228. Willd. n. 1. Swartz Obf. 151. (*W. pinnata*; Linn. Sp. Pl. 515, excluding the reference to Browne.)—Leaves pinnate; leaflets obovate, crenate, smooth on both sides. Capsule roundish-elliptical, bluntish.—Native of the West Indies. The stem, usually shrubby, sometimes becomes a tree, forty feet high, with round, rugged branches; when young angular, and coarsely downy. *Leaves* of six pair, more or less, with an odd one, of obovate, abrupt leaflets, half an inch at most in length, all nearly equal, furnished with one rib and several transverse veins; entire and wedge-shaped towards the base. *Common footstalk* jointed,

each articulation, between the leaflets, winged with a leafy rhomboid expansion, tapering most downward, and hairy at each end. *Clusters* opposite, at the end of each branch, on hairy axillary stalks, dense, about an inch long when in flower; twice as long, and much more lax, when in fruit. *Flowers* very small, white, on fasciculated, short, thick, hairy partial stalks. *Capsules* about half the size of hempseed, brown; their stalks elongated; their valves obtuse, tipped with the styles, and, as they ripen, turning their pale narrow edges, which had formed the partitions, outwards. Permanent styles mostly recurved, rather shorter than the valves. We have not seen the seeds.

2. *W. tinctoria.* Red-tan *Weinmannia*. (*Weinmannia*; Lamarck t. 313. f. 1. Tan-rouge; Commerçon MSS.)—Leaves pinnate; leaflets elliptical, crenate, smooth on both sides. Capsule ovato-lanceolate, taper-pointed. *Seeds* hairy.—Gathered by Commerçon in the isle of Bourbon, where it is known by the name of *Tan-rouge*, because the bark serves to dye leather of a red colour. The flowers are supposed to furnish the bees with much of their honey. French botanists appear to have confounded this plant with the preceding. It is certainly what Lamarck has figured, and what Poir. has quoted, for *W. glabra*, the latter having taken *Tan-rouge* from hence, for his French generic name of the whole genus, though without adverting to its use in the isle of Bourbon, or its being a native of that country. The leaves are full twice the size of *W. glabra*, with elliptical, not obovate, leaflets: wings of their footstalks similar to the last. *Clusters* of flowers much more lax, and less hairy, three or four inches long; the flowers twice as large. *Capsules* of a very different shape, and paler redder hue, tapering into the straight erect styles, which are not a quarter so long as the valves, nor are the edges of the latter ever turned outward, or flattened. The clusters of ripe capsules are cylindrical, dense, four or five inches in length. *Seeds* clothed with a few long prominent hairs.

3. *W. hirta.* Hairy-leaved *Weinmannia*, or Bastard Braffetto. Swartz Ind. Occ. 691. Willd. n. 2. Poir. in Lam. n. 3.—Leaves pinnate; leaflets elliptic-ovate, crenate, hairy at the back. Capsules oblong.—Native of lofty mountains in the south part of Jamaica, in St. Andrew's parish, near Coldspring, the residence of Matthew Wallen, esq. (See WALLEIA.) This, according to Dr. Swartz, from whom we have a specimen, is a very rare species. It is either a shrub, or a handsome tree, from forty to fifty feet high, crowned at the very top of its smooth trunk with lax, hairy, or somewhat downy, rusty-coloured branches. The leaves most resemble the last in shape, but are clothed beneath, sometimes on both sides, with coarse, scattered, prominent hairs. The leafy borders of each joint of the common footstalk are narrower, and less angular, than those of our first or second species, and their midrib is very hairy beneath. *Clusters* also very hairy, an inch or two in length, in pairs at the summits of the branches. *Flowers* the size of the last, white. *Capsule*, according to Swartz, small, oblong, rather pointed, with several small roundish seeds. This tree flowers in September and October. Some specimens, in the herbarium of the younger Linnæus, excite a doubt whether the hairiness of the foliage may invariably be relied on. Still we have no doubt of the distinctness of these three species. The third is perhaps most allied to the second, which appears to be what Dr. Swartz saw marked *W. arborea*, and which Commerçon was said to have gathered in the isle of Mauritius. We do not at all comprehend how the joints of the common footstalk can be termed "somewhat heart-shaped," in *W. hirta*; they are rather more truly obo-

vate than in either of the foregoing, being less angular, or deltoid.

4. *W. trichosperma*. Hairy-seeded Weinmannia. Cavan. Ic. v. 6. 45. t. 567. Poiret n. 2.—Leaves pinnate; leaflets elliptic-oblong, serrated, smooth on both sides. Capsule roundish-elliptical. Seeds densely hairy.—Gathered by Louis Née, at San Carlos, in Chili, bearing ripe capsules in February. *Cavanilles*. By the plate above quoted, this bears most resemblance to the first species, especially in the acute angles of the deltoid articulations of the *footstalks*, which in all the other species are rounded. But the *leaflets* are longer and more elliptical, serrated rather than crenate; the *capsules* broadly elliptical, not obtuse, their inflexed edges, if the figure be accurate, much broader, and continuing inflexed. The *seeds* are roundish-kidney-shaped, clothed with long, copious, projecting hairs, of which no mention is made by any botanist who has described the *seeds* of *W. glabra* or *W. hirta*, and therefore we must presume they do not exist in those species. We find such hairs, very sparingly, on the globular *seeds* of *W. tinctoria*, but the *capsules* of that species are abundantly different from the present.

5. *W. tomentosa*. Woolly Weinmannia. Linn. Suppl. 227. Willd. n. 3. Poiret n. 4.—Leaves pinnate; leaflets elliptical, revolute, entire, woolly beneath.—Gathered in New Granada, by Mutis. A very distinct and remarkable species. The *branches* are woody, round, densely leafy, rough, somewhat warty, of a dark brown; hoary and downy when young. *Leaves* hardly an inch and a half long; leaflets about five pair, with an odd one, each one-third of an inch in length, convex, slightly hairy, single-ribbed; the under side clothed with copious, loose, hoary, woolly hairs. The joints of the common *footstalk* are rather shorter than the leaflets, obovate, not angular; their edges revolute, and the under side woolly. *Stipulas* large, ovate, reflexed, coloured, hairy externally, deciduous. *Flowers* in very dense *clusters*, rather above an inch long, on thick, short, woolly, axillary stalks. *Calyx* hairy. *Capsules* wanting in our specimens.

6. *W. trifoliata*. Three-leaved Weinmannia. Linn. Suppl. 227. Thunb. Prodr. 77. Willd. n. 4. Poiret n. 5. Lamarck f. 2.—Leaves ternate; leaflets obovate, crenate, smooth.—Gathered by Thunberg, at the Cape of Good Hope. The whole *shrub* is said to be very smooth. *Leaflets* equal, about an inch long, being about two-thirds the length of their common *footstalk*, which is simple and naked. *Clusters* cylindrical, dense, two or three inches long, on axillary stalks about half their own length. The *germen* in Lamarck's figure is roundish and hairy. We have seen no specimen, nor is there any account of the *capsule* or *seeds*.

SECT. 2. *Leaves simple*.

7. *W. racemosa*. Smooth-clustered Simple-leaved Weinmannia. Linn. Suppl. 227. Willd. n. 5. Forst. Prodr. 27. Poiret n. 580.—Leaves simple, stalked, ovate, with tooth-like serratures. Clusters axillary, solitary, nearly smooth.—Gathered by Forster, as well as by Menzies, in New Zealand. The *branches* are stout, woody, repeatedly branched in an opposite manner, round and rough. *Footstalks* stout, smooth, half an inch long, articulated at the summit with the leaf, which is two, or two and a half, inches long, and one broad, pointed, coriaceous, quite smooth, strongly veined, beset with blunt, inflexed, wavy teeth, or serratures; paler beneath. *Clusters* about the tops of the branches, though axillary, stalked, longer than the leaves, cylindrical, continuous; their general and partial *stalks* either slightly downy, or quite smooth. *Capsules* obovate, pointed, some-

what downy; the inflexed edges of their valves finally expanded. We cannot find a *seed* in any of our specimens.

8. *W. parviflora*. Small-flowered Weinmannia. Forst. Prodr. 29. Willd. n. 6. Poiret n. 7.—“Leaves, simple, nearly sessile, ovate, pointed, with tooth-like serratures. Clusters terminal, aggregate, hairy.”—Native of Otaheite. *Forster*. Willdenow, who had seen a dried specimen, describes the *branches* as hairy when young. *Leaves* on short stalks, oblong, smooth on both sides. *Clusters* downy, from three to six at the top of each branch, forming a sort of panicle. *Flowers* but a quarter the size of the preceding.

9. *W. ovata*. Ovate-Crenate Weinmannia. Cavan. Ic. v. 6. 45. t. 566. Poiret n. 9.—Leaves simple, elliptical, crenate, acute at each end, on short stalks. Clusters axillary, solitary, opposite, somewhat downy.—Native of Peru, in a large alluvial excavation, near the town of St. Buenaventura, flowering in June and July. This is a *tree* eighteen feet high, with furrowed, rather knotty *branches*, thickened at the insertion of the *leaves*, which seem very like those of *W. racemosa* in shape, size, veins, and smoothness, but are more truly crenate, and stand on shorter *footstalks*. *Clusters* opposite, at the tops of the branches, though axillary and solitary, each two or three inches long; their partial stalks aggregate, and somewhat villous. Nothing is known of the *capsule* or *seeds*. We could wish for better materials than *Cavanilles* affords us, for distinguishing this species from the *racemosa*, n. 7.

10. *W. paniculata*. Panicked Weinmannia. Cavan. Ic. v. 6. 44. t. 565. Poiret n. 8.—Leaves simple, elliptic-lanceolate, sharply serrated. Panicles axillary, compound.—Gathered by Louis Née, at the sea-shore near Talcahuano, in Chili, flowering in February. A *tree* about the stature of the last, but the *leaves* are longer, more lanceolate, with parallel veins, and copious sharp serratures, which give them some resemblance to the sweet-chestnut leaf. They are smooth, and stand on stout downy *footstalks*. The panicked *inflorescence* is singular among all the known species. *Flowers* yellowish-red. *Capsules* elliptical, acute, downy, beaked with the straight *styles*, which are as long as the valves. *Seeds* obovate, smooth, on slender stalks, pendulous. We have a specimen from the late abbé Cavanilles.

WEINSBERG, in *Geography*, a town of Wurtemberg; a part of which is built on a round hill, on which also stands a ruined castle: the other part lies in a valley. In it is a special superintendency. The valley in which it lies is famous for wine; 5 miles N.E. of Heilbronn.

WEINSTEIG, a town of Austria; 8 miles N. of Korn Neuburg.

WEINZIERL, a town of Austria; 8 miles S.E. of Ips.

WEIPERSHOFEN, a town of the principality of Anspach; 5 miles S.E. of Creilshelm.

WEIPERT, a town of Bohemia, in the circle of Saatz; 14 miles W. of Commotau.

WEIR, one of the smaller Orkney islands, containing about 65 inhabitants. It had formerly a church, which is now in ruins; 2 miles S. of Rousa.

WEIR, or WEAR, in *Rural Economy*, a sort of dam, bulwark, or strong erection, formed across a brook, rivulet, stream, river, main, or other such water-course, for the purpose of diverting or turning the water, in watering land. It is occasionally made in different ways, as of timber alone, sometimes of bricks, or stones, and timber, and of different other materials, as will be seen below, having from two to eight or ten thoroughs or openings for letting the water pass through, according as the breadth of the

stream and other circumstances may be. The height of it is always equal to the depth of the stream compared with the adjacent land.

The water of a very small and gentle stream may often be diverted for this use, by means of a few fods firmly put down, with some stones above them: but for lands of any considerable extent, the kinds directed below are necessary, according as the strength of the respective streams may happen to be.

Strong wooden beams or balks thrown across the stream, and made close by means of boards well secured, are, in many cases, sufficiently strong, commodious, and convenient, in slow moving waters, of no great power or force.

A few cart-loads of stones thrown properly in across the stream, forms also a bulwark, wide at the base, and narrowing towards the top, the whole being puddled with clay or gravelly earth, which sometimes answers well. Over the top of this bulwark, the superfluous waters pass in a free manner, falling down the gentle slope, to which, if well constructed, they do no sort of injury.

A weir suitable for a small river may consist too of several rows of stakes, firmly driven down and interlaced with the branches of fir-trees, the intervals of the rows being filled with stones. The sand and mud that come down with the floods fill up this sort of weir, and render it fit for effecting its purpose. In heavy rains the superfluous water passes entirely over.

But for more powerful rivers, the weirs may be constructed of strong frame-works of wood, firmly and strongly joined together, and the different compartments all paved with large stones: the weir rising very gradually against the stream, and being made to slope gradually away before it, as it flows over it. In this way the largest and most powerful rivers may mostly be managed, if the weirs be well suited to them; so that it is but in few cases advisable to attempt the watering lands from rivers that cannot be diverted by one or other of these sorts of weirs, as the expense and hazard taken together may greatly exceed the advantage to be derived: It may, however, in some cases of large rivers, be necessary and proper to have recourse to more expensive weirs, such as that described below.

In this weir, which was formed on a large, rapid, and strong river, under the direction of the Rev. W. H. Coham, in Devonshire, after the stream had been temporarily diverted, and every thing removed for a proper foundation, a double row of pits was dug into a rocky substratum, directly across the bottom, or bed of the river, at about five feet asunder lengthways, by four feet in breadth, and about two feet in depth; and into these pits oak posts of about six or seven inches square were fixed. The mason then raised a perpendicular wall, without any cement, about five feet and a half thick, entirely enclosing the posts, the labourers being employed in the mean time in *backing up* the wall on the higher side with some of the *stiffest* clay to be had. This was, however, afterwards found to be wrong; it should have been done in the *puddle* manner, by means of mould and gravelly earth.

When the wall was raised to such a height as was deemed necessary, in relation to the level required, and the preservation of the lands adjacent, the upper parts of the oak posts were sawn off, in order to receive cross-pieces and joists, the front posts being then left to stand about six inches higher than the hinder ones; and on these joists oak planks were pinned, about six feet and a half long by three inches thick. These planks were brought forward to project about

one foot and a half over the perpendicular of the wall, on the lower side, forming a sort of lip, as it has been termed; the clay, together with these planks, constituting an inclined plane, and terminating at the distance of about fifteen feet up the stream, on the common bed of the river.

The entrance for the *leat* was cut at about thirty feet above the *lip* of the weir, where, to regulate the quantity of water to be admitted, three strong flood-hatches, to be lifted or let down by a lever and windlafs, were placed; and through which a column of water, of about eight feet in width by four feet in depth, may be introduced at any time. Between the leat and the river a stone wall, strongly cemented, is erected, which is about eight feet in height, and carried from the head of the leat to about thirty feet below the weir, in a parallel line with the river, and at the end of which wall another flood-hatch is fixed on a level with the bed of the river. This latter hatch will always be of great advantage when any reparations may be wanting on the weir; as on drawing it up when the water is low, the weir in a few hours will be left perfectly dry, and the workmen, with the greatest convenience, may proceed in their operations. From the top of the side wall, above the weir, the ground is made sloping to the river, and below it is covered with turf, and levelled as a foot-path.

Immediately below the weir, in this case, there is an outlet regulated by another flood-hatch, and conducted through a *shoot* formed of oak plank, from the leat, and contrived for the admission of salmon, which are there sometimes taken; and below the lower flood-hatch, a trap, or *willey*, as it is there termed, is made for the catching of smaller fish: this part of the work does not, however, properly belong to this kind of weir, therefore it need not be more noticed.

The height of the weir is about four feet above the level of the river where it is fixed; and its length, from bank to bank, directly across, or at right angles with the stream, is about forty-eight feet; forty feet of which is carried at a perfect level, and over which the water falls precisely at the same depth, forming a beautiful cascade. The remaining portions of the length of the weir, namely, four feet on each side, are raised, gradually ascending to the banks for the purpose of warding off the torrent from them in time of floods, when the river, in this case, is very tumultuous.

The lip part of the weir is found to answer perfectly; as in proportion to the force of the water behind, so is the distance which it is thrown over the weir from the foundation of the perpendicular wall.

If the writer had not been foiled, and had part of the work to perform over again, in consequence of the use of clay, as already noticed, being under the necessity of driving on the weir in a direct line with the former work, into the side of the opposite bank, as before; and after removing as much of the clay as could be got at, which will not unite completely with the soil, but become liable to be undermined by the water, by making a *puddle*, as used in canals of mould and gravel, in its stead, which succeeded in a complete manner; the whole cost of the weir would not have exceeded 75*l*.

This weir or wear, from its present appearances, may now, it is said, seem to bid defiance to time; and be safely recommended as a pattern to those who may have occasion to construct any thing of a similar kind, either for watering land, for machinery, or other uses. See WATERING Land.

In the weirs or wears which are thrown over large rivers for the purpose of raising the water for the use of mills, and in many other intentions, and which are mostly constructed

of stone, with strong framed wood-work, in somewhat the above manner, there are many different contrivances calculated for different uses, such as locks for securing large fish, places for taking and preserving those of the smaller sorts, and different others. See Dr. Anderson's Treatise on the Erection of Weirs, &c. where a full explanation of the principles and manner of constructing them will be found.

WEIS SEE, in *Geography*, a lake of the duchy of Carinthia; 10 miles N.W. of Velach.

WEISA, a town of Saxony, in the circle of Erzgebirg; 3 miles S.S.W. of Wolkenstein.

WEISBRON. See VESPRIN.

WEISCHE OPPA, a river of Silesia, which runs N.E. into the Schwartz Oppa.

WEISCHENFELD, a town of Bavaria, in the bishopric of Bamberg; 18 miles E.S.E. of Bamberg. N. lat. 49° 49'. E. long. 11° 19'.

WEISDORF, a town of Germany, in the principality of Culmbach; 3 miles E. of Munchberg.

WEISEN, a town of Prussia, in the province of Oberland; 10 miles W.S.W. of Leibstadt.

WEISENBAD, a town of Saxony, in the circle of Erzgebirg; 3 miles S.S.E. of Wolkenstein.

WEISENBERG, a township of Pennsylvania; 60 miles N. of Philadelphia.

WEISENBERG, or WOSSBERK, a town of Lusatia; 8 miles E. of Budissen. N. lat. 51° 12'. E. long. 14° 40'.

WEISENBRUN, a town of Bavaria, in the bishopric of Bamberg; 24 miles S. of Cronach.

WEISENBURG, a town of Austria; 12 miles S.S.W. of St. Polten.

WEISENBURG. See WEISSEMBURG.

WEISENHORN, a town of the duchy of Baden, situated in a county to which it gives name, on the Roth; 11 miles S.E. of Ulm. N. lat. 48° 17'. E. long. 10° 8'.

WEISENKIRCHEN, a town of Austria; 11 miles S.W. of Tulln.

WEISFURT, a river of Silesia, which runs into the Oder, 3 miles below Beuthen.

WEISKIRCH, a town of Bohemia, in the circle of Boleslaw; 3 miles S.S.E. of Krottaw.

WEISKIRCHEN, or HRANITZE, a town of Moravia, in the circle of Prerau; 15 miles E.N.E. of Prerau. N. lat. 49° 30'. E. long. 17° 43'.

WEISMAYN, a town of Bavaria, in the bishopric of Bamberg; 20 miles N.E. of Bamberg. N. lat. 50° 6'. E. long. 11° 18'.

WEISSE, CHRISTIAN-FELIX, in *Biography*, a German poet, was born in 1726, at Annaberg, in Saxony, and educated, first at the Gymnasium of Altenburg, and afterwards at Leipzig. The objects to which his taste most powerfully inclined him were poetry and the drama; and he and his friend Lessing concurred in translating for the stage from French and English works, and afterwards in furnishing original compositions. He also contended with his friend in lyric poetry. After completing his course of education, he became private tutor in a family of distinction at Leipzig, pursuing his dramatic and poetical career, and gaining a great degree of popularity. He also edited the Bibliotheque of Belles Lettres, when Nicholai surrendered it. Although, in 1761, he obtained a place in the revenue at Leipzig, he prosecuted his employment as a writer for the stage; and when he became the father of a family, he directed his attention to education, and published several pieces in this department: particularly, in 1772, a collection of short tales and moral maxims, which had a consider-

able circulation; and in 1775 he revived a weekly publication, which Adelung had discontinued, under the title of the "Children's Friend." This work became afterwards a quarterly publication, and between the years 1775 and 1782, passed through five editions. From this popular work Berquin derived the idea of his "Ami des Enfans," and he was indebted to it for many of his materials. As Weisse's children grew to maturity and settled in the world, he altered the plan of his work, and continued it under the form of Letters; and Berquin also followed him in his "Ami des Adolescents." In 1790 the beautiful estate of Stotteritz near Leipzig, which Weisse inherited, placed his family in affluent circumstances, and furnished him with a pleasant residence. Towards the latter part of his life he contributed short fables and poetical tales to journals and periodical publications, which were well received, and at length closed his life with reputation, in December 1804. His dramatic works, which were continued to five volumes, are said to have formed an epoch in the history of the German stage, and both his translations and original compositions were well received. Gen. Biog.

WEISSE, in *Geography*, a river of Prussia, which runs into the Rufs, 20 miles N.W. of Tilsit.

WEISSEBERG, a mountain of Bohemia, celebrated for the defeat of the elector-palatine, about 3 miles from Prague.

WEISSELBURG, a town of Prussia, in the province of Oberland; 5 miles S. of Marienwerder.

WEISSELMUNDA. See WEICHELSELMUNDE.

WEISSEMBURG, or KORN WEISSEMBURG, or *Weisseburg*, a town of France, and principal place of a district in the department of the Lower Rhine, situated on the Lauter, at the foot of the Vosges. This town was formerly imperial, and was ceded to France by the peace of Ryfwick. The fortifications were destroyed by Louis XIV.; but strong lines of defence are fixed from this town to the Rhine, a little to the east of Lauterburg, on the S. side of the Lauter; 27 miles N. of Strasburg. N. lat. 49° 3'. E. long. 8°.

WEISSEMBURG, a town of Bavaria, called *Weisseburg near the Nordgau*. It contains two churches and a medicinal spring. Weisseburg was an imperial town, till in 1802 it was given to the elector of Bavaria; 28 miles S.S.W. of Nuremberg. N. lat. 48° 58'. E. long. 10° 55'.

WEISSEMBURG, or *Alba Julia*, or *Carlsburg*, or *Fejervar*, a town of Transylvania, capital of a county, and see of the bishop of Transylvania, beautifully situated on the Maros. It was a long time the metropolis of Dacia, and the seat of its monarchs, who had a palace here. It was likewise the seat of a Roman legion. The name Alba Julia it owes to Julia Augusta, mother of Marcus Aurelius. Charles VI. named it Carlsburg; 90 miles N.E. of Temesvar. N. lat. 46° 16'. E. long. 24° 10'.

WEISSEN SEE, a lake of Prussia; 12 miles W. of Lick.—Also, a lake of Bavaria, in the territory of Augsburg; 2 miles S.W. of Fuesfen.—Also, a lake of Carinthia; 6 miles S. of Saxenburg.

WEISSENAU, a princely abbey of Germany, in the circle of Swabia. In 1802 it was given to the elector of Bavaria; 2 miles S. of Ravensburg.

WEISSENBACH, a town of the principality of Culmbach; 5 miles E. of Kirch Lamitz.—Also, a town of Austria; 12 miles N. of Grein.—Also, a town of Austria; 9 miles W. of Freystatt.

WEISSENBERG, a township of Pennsylvania, in the county of Northampton, containing 1046 inhabitants.

WEISSEN-

WEISSENBORN, a town of Saxony, in the circle of Erzgebirg; 3 miles S.S.E. of Freyberg.

WEISSENBURG, a town of Saxony, in the circle of Erzgebirg; 5 miles S.S.W. of Zwickau.—Also, a village of Switzerland, in the canton of Berne, celebrated for its medicinal baths; 18 miles S. of Berne.

WEISSENDORF, a town of Bavaria, in the bishopric of Bamberg; 9 miles S.W. of Forcheim.

WEISSENFELS, a town of the duchy of Carniola; 28 miles W.N.W. of Crainburg.—Also, a town of Thuringia, on the Saal. It gives title to a branch of the house of Saxony, called Saxe Weissenfels, who ordinarily reside in a citadel above the town, called Augustusberg; 18 miles W.S.W. of Leipzig. N. lat. $51^{\circ} 14'$. E. long. $11^{\circ} 59'$.

WEISSENHORN, a town and citadel of Bavaria, which gives name to a county belonging to the lords of Fugger; 8 miles S.E. of Ulm.

WEISSENKIRCH, a town of Bavaria, in the principality of Aichtatt; 3 miles S.S.E. of Aichtatt.

WEISENPACH, a town of Austria; 4 miles N.W. of Bohmisch Waidhoven.

WEISSENSEE, a town of Thuringia, near what formerly constituted an inland lake, which was divided into the Great and Less, or into the Upper and Lower, between both which it lay; but the former being drained in the year 1705, and converted into arable and meadow grounds, a small part of it only being then left; and this also has been since dried up; 14 miles N. of Erfurt. N. lat. $51^{\circ} 10'$. E. long. $11^{\circ} 6'$.

WEISSENSTADT, a town of Germany, in the principality of Bayreuth, on the Egra, where it forms a large pond or lake, abounding in fish; 6 miles N.N.W. of Wunsiedel.

WEISSENTHURN, a town of Slavonia; 18 miles N.N.W. of Verovitza.—Also, a town of the duchy of Stiria; 3 miles E.S.E. of Judenburg.

WEISSESTEIN, a town and castle of Bavaria; 10 miles N.N.E. of Deckendorf.

WEISSIA, in *Botany*, an Hedwigian genus of Mosses, is now, by nearly universal consent, united to GRIMMIA, for reasons given under that article. There is indeed no difference of habit, nor any certain character, however minute and obscure, between them. This is the more to be regretted, as we have few more meritorious claimants for distinction in cryptogamic botany than Mr. Frederic William Weis, author of the *Plante Cryptogamice Florae Gottingensis*, an octavo volume, printed at Gottingen, in 1770. No student in that department of the science can dispense with this little book, in which the synonyms of the descriptions are treated with equal practical skill. *Fungi*, and necessarily Sea-weeds, are excluded from this *Flora*. We trust some responsible author will restore a *Weissia*, worthy of bearing the name. The double *fs* is a blunder which requires correction.

WEISSLAREUT, in *Geography*, a town of Germany, in the principality of Culmbach; 4 miles S. of Hof.

WEISSNITZ, or WEISSERITZ, a river of Saxony, which rises in two branches, the Wilde and Rothe, which unite two miles E. of Tharand, and afterwards run into the Elbe, near Dresden.

WEISTHURN, a town of Bohemia, in the circle of Koniggratz; 6 miles W. of Schlan.

WEISTRA, a town of Austria; 5 miles E. of Steyr.

WEISTRITZ, a town of Silesia, in the principality of Schweidnitz, on a river of the same name. Gold is found in the environs; 2 miles S. of Schweidnitz.

WEISTRITZ, a river of Silesia, which runs into the Oder, near Schweidnitz.

WEISWASSER, a town of Bohemia, in the circle of Boleflaw; 6 miles N.W. of Jung Buntzel.—Also, a town of Silesia, in the principality of Neisse; 4 miles S.W. of Patfchkau.

WEISZBACH, a town of Saxony, in the circle of Erzgebirg; 5 miles N.N.W. of Wolkenstein.

WEITENFELDS, a town of the duchy of Carinthia; 2 miles W.S.W. of Gurck.

WEITENHAGEN, a town of Anterior Pomerania; 2 miles S.S.W. of Griefswalde.

WEITENSTEIN, a town of the duchy of Stiria; 8 miles S.E. of Windfisch Gratz.

WEITRA, or WEITRACH, a town of Austria; 36 miles N.W. of Crems. N. lat. $48^{\circ} 41'$. E. long. $14^{\circ} 59'$.

WEITRASILD, a town of Austria; 2 miles S. of Hardegg.

WEITTENEG, a town of Austria, on the Danube; 18 miles above Crems.

WEITZ, a town of the duchy of Stiria; 11 miles N.E. of Gratz.

WEITZSBERG, a mountain of Stiria; 10 miles N.E. of Gratz.

WEIXEN, a river of Austria, which runs into the Danube, 3 miles below Grein.

WEIZLPACH, a town of Austria; 12 miles W.S.W. of St. Polten.

WEKLSDORF, a town of Bohemia, in the circle of Koniggratz; 7 miles N.W. of Branau.

WELACH. See VELACH.

WELANG, a small island in the East Indian sea. S. lat. $1^{\circ} 25'$. E. long. $130^{\circ} 30'$.

WELAU, a town of Prussia, in the province of Samland; 28 miles E.S.E. of Königsberg. N. lat. $54^{\circ} 36'$. E. long. $21^{\circ} 23'$.

WELCH MOUNTAINS, mountains of Pennsylvania; 30 miles W. of Philadelphia.

WELCHEIM, a town of Bavaria; 7 miles N.W. of Neuburg.

WELCKERSHAUSEN, a town of Germany, in the county of Henneberg; 3 miles N. of Meinungen.

WELCOME BAY, a bay on the west end of the island of Java. S. lat. $6^{\circ} 35'$. E. long. $105^{\circ} 30'$.

WELD, or WOLD, *refeda luteola* of Linnæus, a plant used by the dyers to give a yellow colour; and for this reason called, in Latin, *luteola*, of *luteus*, yellow. For the characters, see RESEDA.

When the plants are pulled, they may be set up in small handfuls to dry in the field, and when dry enough, tied up in bundles and housed dry; care being taken to house them loosely, that the air may pass between them to prevent their fermenting. That which is left for seeds should be pulled as soon as the seeds are ripe, and set up to dry, and then beat out for use; for if the plants are left too long, the seeds will scatter. Mortimer and Miller.

Weld is much cultivated in Kent, for the use of the London dyers.

Mr. Hellot observes, in his Art de Teindre, that for dyeing with weld, the best proportions of alum and tartar for the preparatory liquor are four parts of alum, and one of tartar, to sixteen of the wool; the quantity of the tartar being determined by the greater or less brightness of colour proposed; and that the wool, thus prepared, is to be boiled again with three or four parts of weld to one of wool, but often much less: that for light shades, it is customary to diminish the alum, and omit the tartar; and that, in this case,

case, the colour is more slowly imbibed, and proves less durable.

With a view to economy, the weaker shades of colour are dyed in the same bath, after the stronger are finished. A golden yellow, more or less orange, is given by a weak madder bath, after the welding.

Silk is dyed of a golden-yellow, generally with weld alone, according to the following process: the stuff is first boiled in soap-water, alumed and washed, then passed twice through a weld bath, in which, the second time, some alkali is dissolved, which gives a rich golden hue to the natural yellow of the weld. The colour is further deepened by a little annotto. The solutions of lime with weld give to silk a bright clear yellow. In order to dye cotton yellow, Berthollet directs first to cleanse it with wood ashes and water, to rinse, alum, and dry without further rinsing, and then to pass it through a yellow bath, in which the weld is somewhat more than the weight of the cotton. When the colour has sufficiently taken, the cotton is thrown into a bath of sulphate of copper and water, and kept there for an hour; after which it is boiled with white soap-water, and, lastly, washed and dried. In order to obtain a deeper jonquil-yellow, the aluming is omitted, and, instead of this operation, a little verdigris is added to the weld bath, and the cotton finished with soda.

Weld is particularly preferred to all other substances in giving the lively green lemon-yellow. It is, however, expensive; and it is also found to degrade and interfere with madder colours more than other yellows. We may here add, that the fine delicate yellow, obtained from weld, is much used by the London paper-stainers, and sold in the form of hard lumps, consisting chiefly of chalk saturated with the colouring matter. Messrs. Collard and Frazer have given the following improved process:—Dissolve any quantity of fine whiting in boiling water; add to it one ounce of alum for every pound of whiting, which will occasion a brisk effervescence, and stir these materials well together till the gas is wholly disengaged. On the other hand, boil in a separate vessel some weld with water just sufficient to cover it, for fifteen minutes, filter the yellow decoction, and then mix it with the whiting and alumine in such proportions, that the earths may appear to be saturated with the colouring matter. Then let the mixture remain a day at rest, and at the bottom will be the precipitated earth firmly united with the colour, and of a fine yellow tinge, which may be conveniently dried on chalk-stones.

The weld yellow is a water colour, and is never mixed with oil.

WELD, in *Agriculture*, is a plant which is not unfrequently cultivated in the field by the farmer as a crop, for the purpose of giving and affording a bright yellow and lemon colour to woollens, silks, cotton, and thread, as well as for its use in the manufacture of check and fustian, and in some other intentions. It is for the flower-stems that it is principally grown, as being useful in the process of dyeing these several articles. It is often known by the names of *woold* and *dyer's weed*.

It may be noticed, that in the growth and culture of this plant, the soils most suitable are those of the fertile mellow kinds, whether of the loamy, sandy, or gravelly sorts; but it may be grown with success on such as are of a poorer quality; but in the former, the plants will rise to a much greater height, and produce much larger leaves and stems, than in the latter description of lands.

It has, however, been stated, that the soil most suitable to it, in *Essex*, is the strong stiff loam moderately moist,

but not wet. A soil rather moist, but mellow, seems the most suitable and proper for it.

It is necessary, in the preparation of the ground, that there should be a tolerable degree of fineness produced in the mould of the soil, which may be effected by repeated ploughings given in the more early spring months, and suitable harrowings. The surface of the land in the feed furrow should be left as level as possible, that the seed may be dispersed more evenly over it, and with greater regularity and exactness.

In this, as in many or indeed most other cases, the seed should be collected from the best plants, and those which have remained upon the stems till rendered perfectly ripe; as such only vegetates perfectly, and the plants in such cases should not be left stand too long, as the seed is liable to shed. It should be perfectly fresh when used, as old seed never comes up well, or in so regular a manner.

In regard to the proportion of seed which is necessary, it is commonly from about two quarts to a gallon the acre, according to circumstances, when sown alone: but when mixed with other crops, a little more may be required, which should be blended with a little sand, or some other such material, at the time of sowing it on the land, as rendering it capable of being sown more evenly.

It may be observed in respect to the time of sowing, that this sort of crop may be put into the ground either in the spring, as about the latter end of April or beginning of May; or in the latter end of summer, as the beginning of August; being mostly sown in conjunction with other crops in the first period; but when sown alone at the latter season, the produce is in general the best and most full. Some of the writers in the *Essex Report on Agriculture* speak of the culture of this sort of crop as simply that of transplanting from the feed-beds about Midsummer. The seed, in these cases, is sown in the beds in the early spring, for raising the plants. In the county of Norfolk, it is said, that they sow it in the month of April with barley, in the proportion of from a quarter to half a peck to the acre, in the manner of clover, and frequently with clover at the same time, to be mown or fed in the following year, after the weld is pulled.

It is mostly sown broad-cast, whether grown in mixture with other plants or alone; and as the seeds are of a very small size, it requires an expert seedsmen to perform the business with regularity and exactness, which is a matter of much importance to the success of the crop, as, where the plants stand too closely together, much unnecessary trouble and expence must be incurred in the thinning them out by the hoe afterwards; and where they stand too thinly upon the ground, there must be a great loss from the deficiency of plants. That the sowing may be executed with more regularity, it is the custom with some to blend other substances, such as the above, with the seed that has nearly the same weight, as by this means they suppose it may be effected with greater exactness, facility, and readiness.

It is stated that weld, when grown with other sorts of crops, such as barley, buck-wheat, beans, peas, clover, or grass-seeds, is usually put in after them; in some cases immediately, but in others not till some time has elapsed. With the first and second sorts, when sown so late as the beginning of May, it is mostly the practice to sow it directly afterwards, giving the land a slight harrowing with a very light close-tined harrow to cover it in. The barley being sown under furrow, the weld-feed with some is immediately sown over the surface, and lightly harrowed in, and then rolled. Where the barley seeding is performed so early as

March,

March, or the beginning of April, the sowing of the weld-feed is best deferred till May, when it may be dispersed over the land, and left in that manner to be washed in by the rains. With bean and pea crops, it is often sown before the last breaking or hoeing of the crops in the latter end of June, or beginning of July. In cultivating it with clover and grass-seeds, it is often sown at the same time with them; but a better practice is, perhaps, to delay it till some time afterwards, as both these crops require to be sown at too early a period for this plant to rise safely. But in cases where no other sort of crop is grown with weld, which is probably the best method, it is usually sown evenly over the surface of the land, and covered in by harrowing with a light bush harrow, having afterwards recourse to the roller in light sorts of land.

Though it is common in cultivating crops of this sort, not to pay any attention to them after being sown; yet as the plants are of slow growth, and liable to be greatly injured in their progress by the rising of weeds, it must be of much benefit not only to keep them perfectly clean, but also to have the mould stirred about their roots. In about a month from the time of sowing, the plants are mostly in a state to be easily distinguished; a hoeing should be then given when the weather is dry, which may be performed in the same manner as for turnips only, using somewhat smaller hoes for the purpose. Some direct that the plants in this operation should be set out to the distance of three or four inches; but it is better to let them have more room, as six, seven, or eight inches; which not only lessens the expence of the business, but contributes to the advantage of the crop. In the spring, a second slight hoeing may be practised about March, in a dry time; and if any weeds rise afterwards, a third may be given in May. Where the land has been well prepared, one hoeing in autumn and another in the spring may be fully sufficient. Hand-weeding, though practised by some, is in general too expensive in these cases.

It may be observed, that the proper period for pulling this sort of crop is when the bloom has been produced the whole length of the stems, and the plants are just beginning to turn of a light or yellowish colour, as in the beginning or middle of July in the second year. The plants are usually from one to two feet and a half in height. It is thought by some advantageous to pull it rather early, without waiting for the ripening of the seeds, as by this means there will not only be the greatest proportion of dye, but the land will be left at liberty for the reception of a crop of wheat or turnips; but in this case, a small part must be left solely for the purpose of providing seed. In the execution of the work, the plants are drawn up by the roots in small handfuls, and set up to dry, after each handful has been tied up by one of the stalks, in the number of four together in a sort of erect position against each other, as is done in some other kinds of crops.

It is remarked, that sometimes they, however, become sufficiently dry by turning, without being set up. After they have remained till fully dry, which is mostly effected in the course of a week or two, they are bound up into larger bundles, that contain each sixty handfuls, and which are of the weight of fifty-six pounds each; sixty of these bundles constituting a load. These last are tied up by a string made for the purpose, and fold under the title of woold cord, in many places where this kind of crop is much grown and provided for the dyer and calico-printer.

On account of the weld plant being extremely uncertain in its growth, and the whole crop seldom becoming in a state

to be pulled at the same time, it is proper to have an experienced labourer to direct the business of pulling, in order that the pullers may not proceed at random, but take the different parts as the plants become ready, or in danger from the blight. In which last case, the greatest possible dispatch should be made, as the loss of weight in the produce will daily increase, and the grower be of course greatly injured in the quantity of it.

After the weld is become sufficiently dried, which is known by the crispness of the leaves, and the stems turning of a light colour, and when the plants are ripe, the seeds shelling out; according to some, it should be stacked up lightly in the barn, in order to prevent its taking on too much heat; while others advise, that it should be stacked up closely in the manner of wheat, being left to sweat in the same way as hay, as the more this takes place, the better; the quality of the weld being thereby increased, if there be no mouldiness. When the crop has stood till fully ripened, the feed may be taken before it is put into the barn, which may be easily procured by rubbing, or slightly beating each of the little handfuls against each other over a cloth, tub, or any other convenient receptacle, as, by threshing, the quantity of the weld would be much reduced in weight. The price of this sort of feed is mostly about ten or twelve shillings the bushel, which may be sold to the seedsmen in a ready manner.

It may be observed, that in crops of this kind the produce is in some degree uncertain, depending much upon the nature of the season; but from half a load to a load and a half is the quantity most commonly afforded, which is usually sold to the dyers at from five or six to ten or twelve pounds the load, and sometimes considerably more.

This is a sort of crop which is mostly disposed of to the dyers and calico-printers, as well as other manufacturers. The demand for it, however, is sometimes very little; while at other times it is so great, as to raise the price to a very high degree.

Weld is a crop which is particularly liable to be injured by the blight, which probably has induced the growers of it to raise it with those of other kinds, especially of the grass sort; because, where the weld crop does not succeed, a portion of sheep feed may be afforded by the others, for winter and spring use. It is noticed, that the blight frequently comes on so suddenly, that crops which appeared healthy, and in a vigorous state of growth, during the whole of the winter and spring, promising a large produce, are about the month of May attacked by this vegetable disease, so as to be nearly destroyed. It is known to be present by the plants, especially about the lower parts of the stems of them, turning of a yellowish or pale reddish colour, while the upper parts remain green, and seem healthy. When it appears early in the month of May, there is always danger of the crop being destroyed; but when it comes on at a later period, or where the plants from other causes, as the dryness of the season, begin to change colour in the stalks, the only chance is that of having them pulled as expeditiously as the business can be performed, and in the readiest manner possible.

It may be remarked, that it would seem better and more convenient to cultivate this crop alone, or without any mixture of other plants; as, in the former way, it must be much injured and confined in its growth, on account of the closeness and shade produced by the plants of the other crops that surround it. It is the custom, too, when grown with other crops, especially those of the grass kinds, to very commonly feed them down in the winter and spring seasons with

with sheep, or some other light sort of live-stock, under the notion that they will not touch the weld plants; but this is by no means the case, as they are found to feed upon them without any nicety, and must, of course, do very great injury to their growth and flowering. In cases where weld is sown among clover, as is not frequently the case, the best method is probably to pull it out when it has got to maturity, before the clover is cut. Where sown on summer fallowed land with rape and grass-seeds, towards the latter end of that season, in which case it often does extremely well, the crops are mostly fed by lambs in the course of a month or six weeks after the sowing, when little or no injury can be sustained by the cropping of the weld plants.

Weld, on account of the great consumption of vegetable food which it causes, without contributing any thing to the amelioration of the land, can only be introduced with propriety, probably, in situations where manure or substances of that kind can be easily obtained. However, in cases where the crops of this kind are cultivated with sufficient tillage, care, and attention, they may be a good preparation for wheat or turnips, in some instances.

It may sometimes, too, be grown with advantage in the neighbourhoods of large dyeing, printing, and other such manufactories, where the consumption, and consequently the demand for it, are very great. If this sort of produce cannot be disposed of soon after it is pulled and tied up, it may be preserved perfectly found for several years, by being stacked either in the barn or on stands in the open air, taking care to prevent the attacks and ravages of rats, or other vermin.

WELD, or *Weald*, in a *Chorographical Sense*. See WEALD.

WELDEREN, or MARIENBURG, in *Geography*, a town of Germany, in the bishopric of Munster; 3 miles N.E. of Dulman.

WELDING, in the *Manufactures*, denotes the forging of iron, when intensely heated; or, more generally, the intimate union which subsists between the two surfaces of two pieces of malleable metal, when heated almost to fusion, and hammered. This union is so strong, that when two bars of metal are properly welded, the place of junction is as strong relatively to its thickness as any other part of the bar. Welding heat is the heat necessary for producing this effect. Bar-iron cannot be welded to another piece of iron, unless both be heated to nearly 60° of Wedgwood's pyrometer, which is equal to 8.877 of Fahrenheit's scale, and is called the welding heat; but if cast-steel be heated to this point, it would be fused, and run down under the hammer; and, therefore, it was for a long time thought to be impossible to use it in conjunction with iron, in the same manner as the other kinds of steel are employed. But sir Thomas Frankland at length discovered, that if the cast-steel be made only of a white heat, and the iron of a welding heat, the steel will then be soft enough to unite with the iron, and yet the former will not become fluid by the operation. It will, however, be proper to give the necessary temperatures to the two metals separately, and then to unite them at one single heat. (Phil. Transf. for 1795, p. 296.) Mr. Parkes observes, that some nicety is required in the process of welding iron, so that the outside of the weld does not oxidize too much and fly off in scales, before the inside is brought up to a welding heat. When, therefore, a skilful workman is about to weld two pieces of iron, he carefully observes the progress of the heat; and if one becomes too hot, he rolls it in sand to preserve it from the action of the atmosphere; and when one piece acquires the necessary temperature before the other, he covers that with sand,

whilst he is bringing the corresponding piece up to a sufficient heat for its uniting properly with the former. Silica, when mixed with the oxyd of iron, forms a very fusible compound, which covers the work under operation, and prevents a further oxidation of the metal. Iron and platina are capable of a firm union by welding. See sir John Hall's Experiments, in vol. vi. of Edinb. Phil. Transf. p. 71. Parkes's Essays, vol. iv.

WELDING, the proper heat smiths give their iron in the forge, in order to double up the same, when wanted to weld a work in the doublings, so as to be in one piece thick enough for the purpose it is wanted for.

WELDING-Heat is the strong heat, when the iron is prepared to bind.

WELDON, GREAT, in *Geography*, a small market-town in the hundred of Corby, and county of Northampton, England, is situated in Rockingham forest, 4 miles E.S.E. from the town of Rockingham, and 84 miles N.N.W. from London. A weekly market is held on Wednesdays, but on a small scale; and here are four annual fairs. The market-house, over which are the sessions-chambers, supported by columns, was built by lord viscount Hatton. The parish is famous for its quarries of rag-stone, which takes a high polish, and is in great esteem for chimney-pieces, slabs, &c. In the vicinity of this place were discovered, in the year 1738, some fragments of Roman tessellated pavements, one of which was ninety-six feet long, and ten broad. Connected with this were the floors of seven rooms; the centre one, being the largest, was terminated at one end with five sides of an octangular projection. Among the ruins were found several Roman coins of the lower empire. A wall has been built round the Roman pavement, and a wooden roof placed over it. Near Great Weldon, and forming part of the parish, is Little Weldon, a village so called in reference to the town, though exceeding it in population. The whole parish, according to the return to parliament in the year 1811, contained 166 houses, and 815 inhabitants.—*Beauties of England and Wales*, vol. xi. Northamptonshire, by Rev. J. Evans, and J. Britton, F.S.A., 1810.

WELDS, a river of America, which runs into the Connecticut, in the state of Vermont.

WELEDIA, a town of Egypt, on the left bank of the Nile; 5 miles N. of Siut.

WELFORD, a town of England, in Northamptonshire, with 931 inhabitants, including 683 employed in manufactures; 15 miles N.W. of Northampton.

WELHARTITZ, a town of Bohemia, in the circle of Prachatitz; 8 miles N.W. of Schuttenhofen.

WELIN, a town of Bohemia, in the circle of Chrudim; 12 miles N.E. of Chrudim.

WELITZEN, a town of Prussia, in the province of Natangen; 5 miles S.S.E. of Marggrabown.

WELKI, a town of Bohemia, in the circle of Kaurzim; 7 miles N.E. of Prague.

WELL, a town of Hindoostan, in Vissiapour; 12 miles E.S.E. of Raibaug.—Also, a town on the north coast of the island of Sumatra. N. lat. 4° 40'. E. long. 97° 20'.

WELL, a hole dug under ground, below the level or surface of the water collected in the strata.

It is usually of a cylindrical figure, and commonly walled with stone, and lined with mortar.

In sinking wells, it is a consideration of some importance, that they should be lined with free-stone, and not, as is usually the case, with bricks; because most of the bricks which are made in this country, have the property of hardening the water; but the stone does not produce this effect.

M. Blondel informs the Royal Academy of Sciences of a device they use, in the Lower Aultria, which is encompassed with the mountains of Stiria, to fill their wells with water; *viz.* that they dig in the earth, to the depth of twenty or twenty-five feet, till they come to a clammy earth, which they bore into, continuing the operation till the water breaks forcibly out; which water, in all probability, comes from the neighbouring mountains, in subterraneous channels. Caffini observes, that in many places of Modena and Bologna, they make themselves wells by the same artifice. Dr. Derham adds, that the like has been sometimes found in England, particularly in Essex.

In the Philosophical Transactions we are informed, by Mr. Norwood, that, in Bermudas, wells of fresh water are dug within twenty yards of the sea, and even less, which rise and fall with the tides, as the sea itself does. He adds, that, in digging wells in that island, they dig till they come almost to a level with the surface of the sea; and then they certainly find either fresh water, or salt: if it prove fresh, yet, by digging two or three feet deeper, they always come at salt water. If it be sandy ground, they usually find fresh water; but if hard lime-stone rock, the water is commonly salt, or brackish.

Lay-well, near Torbay, ebbs and flows very often every hour; though somewhat oftener in winter than in summer. Dr. Oliver observes, its flux and reflux sometimes return every minute; though, at other times, not above twenty-six or twenty-eight times in an hour. Philos. Transf. No. 104.

In Scotland they have a well, which Sibbald has mentioned as foretelling storms. It is a deep and large well near Edinburgh, and from the noises heard in it at certain times is called by the people the *routing well*. They go to this to listen after the prefaces of weather, and it is said that storms are particularly foretold by it; and that noises are not only heard in it before storms happen, but that they are always heard determinately and distinctly on that side whence the storm will come.

In the Philosophical Transactions we have an account of a boiling-well, &c. See SPRING.

WELL, in *Rural Economy*, a deep circular opening, pit, or sort of shaft, sunk by digging down through the different strata or beds of earthy and other materials of the soil, so as to form an excavation for the purpose of containing the water of some spring or internal reservoir by which it may be supplied, for domestic or other uses of different kinds.

It is usual to have wells bricked round from the bottom to the top, and frequently to have pumps fixed in them. The width is mostly from three to four feet, which, where the springs are strong, may afford and contain a sufficient quantity of water.

As wells are supplied from springs, and these are formed in the bowels of the earth, by water percolating through the upper strata, and descending downwards until it meets with a stratum of clay or other impervious material that intercepts it in its course, it may naturally be concluded, that an abundant spring for this use need never be expected in any district or place that is covered to a great depth with sand, without any stratum of clay to force it upwards, as is the case in the sandy deserts of Arabia, and the immeasurable plains of Lybia. Neither are we to expect abundant springs for wells in any soil that consists of an uniform bed of clay from the surface to a great depth; for it must always be in some porous stratum that the water flows in abundance, and it can be made to flow horizontally in that only, when it is

supported by a stratum of clay, or other substance that is equally impermeable by water. By this means is explained the *rationale* of that rule so universally established in digging for wells, that if begun with sand, gravel, or other such matters, it need seldom be hoped to find water until clay is come to; and that if clay be begun with, none can be hoped for in abundance till sand, gravel, or porous rock is met with.

Hence, as the doctrine of wells is so much and so intimately connected with the nature of the strata and the springs afforded by them, it may not be unnecessary to observe, that in cases where differently formed strata of sand, to a considerable depth, rest upon beds of clay, and have a free issue at the lowest ends of them, if wells were sunk into the sand-beds higher up no water could be there permanently found until they penetrated quite through the strata of sand, and went to some depth into the beds of clay that lie below them. In such cases, the water could never rise in the wells much higher than a certain point; because, whenever it rose as high as the porous sand, it would flow along through it until it made its escape below; and if the beds of clay should extend backwards under the ground a great way, and at a great depth below the surface, so as to form an abundant and never-ceasing stream under the beds of sand, it must necessarily follow, that the wells will continue constantly at the same height, exactly as in the case of a strong basin at a fountain, into which a pipe of water constantly flows, so as to keep it running over.

If, however, the streams that run below the beds of sand be small, and the draught of water from the wells, at particular times, be uncommonly large, the surface of the water in the wells will of course be made to sink: they may be, indeed, quite drained of water at times, so as to require to be left for a while till they shall fill again. This may be occasionally a very serious inconvenience, and ought to be guarded against by enlarging the reservoir, which may be effected either by widening the diameter of the wells, or by sinking them to a greater depth in the clay, or by both these means. Hence it appears, it is said, that in cases of this sort, very wide wells ought always to be made. Other cases, however, will come to be noticed in the course of this article, in which the straightest well that can be made, would supply a quantity of water as abundant as those that are wider. In these cases, pipes as above will be found very useful.

Nor would the phenomena here described, it is said, be in the least varied if the wells, instead of being dug in the sand immediately below the vegetable mould, should be first sunk through a considerable thickness of some other strata. The depth of the well only would be greater, and all other circumstances the same.

It may be here noticed, that quicksand, when it comes in the way of well-digging, affords impediments which can only be surmounted with great labour and difficulty. The best and most obvious remedy in such cases when they occur, is probably to endeavour to find the means of opening an outlet by which the water may be suffered to run off or discharge itself. This, where the quicksand is situated above the level of the sea, or some adjoining plain, may in many cases be effected at very little expence, if due attention be bestowed upon the position and natural dip of the strata, which may be discovered by various means besides boring. But there are cases, particularly where the quicksand is produced by a cavity like a basin scooped out of the entire bottom, so as to contain water to a considerable depth, which in some particular situations may be deemed incurable.

It deserves also to be remarked, as a circumstance necessarily

cessarily accompanying springs of this kind, that the digging wells in a higher position, will not sensibly diminish the quantity of water that flows over the lower surface of the clay; for, as the well, as soon as it is filled, must overflow, that will not intercept one drop more water than what is drawn up out of it. Were it even possible to pump the water from the well as fast as it falls into it, so as never to allow one drop to run over, the case would not be much altered, because no more water could be thus intercepted than that which would have flowed into the mouth of the well in its descent; so that every drop that would pass the mouth of the well, on either side, would flow forward to the lower situation, as if no well had ever been made. Hence we see that springs of this sort can never be intercepted by wells, or sensibly affected by other wells placed either higher or lower than them. Wherever this cause exists, water will be found nearly in equal abundance, whatever the relative situation of the well may be in respect to others: nothing but an uninterrupted trench, of a size sufficient to intercept all the water as it flowed, and to carry it off, could dry up the springs or wells below it.

It may also be observed, that if the bed of sand be of great extent, if it be at last supported by a bed of clay or other impervious matter, water will undoubtedly be there found, whatever may be the depth of the bed of sand above it, if a well be dug through it; for, as the water that falls in showers upon the earth's surface necessarily sinks through that pervious stratum, it is soon beyond the reach of the sun, so as not to be evaporated, and must sink downwards till it meets with an impervious stratum, so that there can be no doubt but that under the immeasurable deserts of Lybia, there must be water in abundance to supply any number of persons, were wells there sunk to the requisite depth; nor is that depth, perhaps, in many cases, nearly so great as has been in general apprehended.

There are many other cases of strata and springs, as concerned in the opening and forming of wells, that constitute different classes of springs for this use, as those where the water is confined and pent up in retentive beds, so as to be capable of supplying wells by simply boring down into them, or making slight openings in other ways, by which the water may flow up. Some instances of these and other sorts will be noticed and considered below.

In the execution of the work of digging wells, there is no great difficulty, the person employed in the business chiefly working down by means of a small short-handled spade and a small implement of the pick-axe kind; the earthy materials being drawn up in buckets by the hand or a windlass fixed over the opening for the purpose. Where persons conversant with this sort of business are employed, they usually manage the whole of the work, bricking round the sides with great facility and readiness; but in other cases, it will be necessary to have a bricklayer to execute this part of the business. As the expence and trouble of digging and getting up the materials in these cases are considerable, other means have been had recourse to, in order to lessen or prevent them. The most ingenious of these is that proposed by a French philosopher, who has advised that the ground should be perforated to a sufficient depth by means of an auger, or borer: a cylindrical wooden pipe being then placed in the hole and driven downward with a mallet, and the boring continued, that the pipe may be forced down to a greater depth, so as to reach the water or spring. In proportion as the borer becomes filled with earth, it should be drawn up and cleared, when by adding fresh portions of pipe, the boring may be carried to much extent under ground, so that water may in most cases be thus reached and

obtained. It is stated that wells made in this manner are superior to those constructed in the common method, not only in point of cheapness, but also by affording a more certain and abundant supply of water, while no accident can possibly happen to the workmen employed. In case the water near the surface should not be of a good quality, the perforation may be continued to a still greater depth, till a purer fluid can be procured; and where wells have become injured or tainted from any circumstance or accident, when previously emptied, and the bottom perforated in a similar manner, so as to reach the lower sheet of water, it will rise in the cylindrical tube in a pure state into the body of the pump fixed for the purpose of bringing it up.

This is certainly an ingenious, ready, and safe method of forming wells; but it requires a large expensive boring auger, and which, if carried to any great depth, would stand in need of an apparatus for being wrought by means of horse-power. Besides, other parts would be necessary, such as punches, chisels, and other such mouth-pieces, for being fixed on occasionally, in order to work through hard strata of many different kinds; and, in some instances, it would be liable to be wholly impeded by the nature of the substances through which it had to get in its passage to the water or spring. In some cases, it may, however, answer in a ready and perfect manner, and be of great use and convenience. There would be much difficulty, too, in driving down the wooden pipes in many cases, especially if to any considerable depth, and great nicety be required in making them so as pretty exactly to fit the aperture formed by the boring auger. And, besides, from their smallness, except they were made from cast-iron, or some other proper metal, they would not by any means be durable, but speedily become leaky and out of order. The best mode would therefore probably be that of having metallic-pipes cast for the purpose, and so formed as to fit exactly upon each other, to any depth that might be necessary in sinking wells.

In some cases and kinds of strata, wells formed in this manner could not, however, answer perfectly, as they require much width or space at the bottom parts, and sometimes to be dug considerably into the impervious bed or matter, as seen above.

It may be necessary and useful to shew the nature of the different beds or layers of materials which are dug or sunk through in forming the openings for wells in different cases, as well as the manner and heights to which the water or springs rise in them under various circumstances. Some cases of wells are stated in the Corrected Report on Agriculture, for the district about the metropolis, that explain these points in a pretty clear manner.

It is noted, that in the year 1791, the present vicar of Northall, then Mr. archdeacon Eaton, agreed with Mr. White, of Putney, to sink a well in the court adjoining to the vicarage. The workmen first dug through a bed of solid blue clay 60 feet in depth, under which was a stratum of rough porous stone about a foot thick. To this succeeded a second stratum of clay, differing a little from the former in colour, 29 feet in depth; then a stratum of fine grey sand, intermixed with extraneous fossils, as oyster-shells, bivalves, &c. This stratum continued for twenty-three feet, and was succeeded by another of clay, of a red or ferruginous colour, less firm in its consistence than that which occurred before, and intermixed now and then with gravel and stones of a considerable size. After digging through this stratum for fifty-one feet, at the depth of one hundred and sixty-four feet from the surface, water was found, which, on the removal of the stone which lay immediately

diately over, the spring burst up with such force, and in such abundance, that the workmen immediately made the signal to be drawn up. Within the first four hours after its discovery, the water rose to the height of eighty feet, in the next twenty-four hours about forty feet more; after which it continued to rise gradually for the next fortnight, till it reached its present level, which is only four feet from the surface of the earth, the depth of the water being now only one hundred and sixty feet.

Depths of strata passed through :

	Feet.
1 Clay - - - -	60
2 Stone - - - -	1
3 Clay - - - -	29
4 Sand - - - -	23
5 Clay - - - -	51
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At Mr. Munday's brewery at Chelsea, a well was dug about the year 1793, to the depth of three hundred and ninety-four feet, within twenty or thirty feet of the edge of the river, mostly through a blue clay or marl. At the depth of near fifty feet, a quantity of loose coal, twelve inches in thickness, was discovered; and a little sand and gravel were found about the same depth. The well-digger usually bored about ten, fifteen, or twenty feet at a time lower than his work, as he went on; and on the last boring, when the rod was about fifteen feet below the bottom of the well, the man felt, as the first signal of water, a rolling motion, something like the gentle motion of a coach passing over pavement. Upon his continuing to bore, the water presently pushed its way by the side of the auger with great force, scarcely allowing him time to withdraw the borer, put that and his other tools into the bucket, and be drawn up to the top of the well. The water soon rose to the height of two hundred feet.

In 1794, a well was sunk at Norland-house, for Mr. Vuliamy, a little on the road towards the town of Uxbridge, to the depth of two hundred and thirty-six feet, and then a hole of five inches and a quarter was bored down, and a copper pipe of the same diameter as the borer, was driven down to the additional depth of twenty-four feet into a stratum of sand filled with water; when a mixture of sand and water instantly rushed upwards through the aperture of the pipe in such abundance, as to rise one hundred and twenty-four feet, that is, one hundred feet in the well part, and twenty-four in the pipe, in the course of eleven minutes, and one hundred and nineteen feet more in one hour and nine minutes; or on the whole it rose two hundred and forty-three feet in one hour and twenty minutes. A found line was then let down, which discovered that sand had rose in such quantity as to fill the well to the height of ninety-six feet. This was under the necessity of being repeatedly dug out, by which the sand was ultimately reduced so considerably as to permit the water to rise through it more and more freely, until it flowed over the top of the well at the rate of forty-six gallons in the minute. There is still, however, a great body of sand in the well, through which the water filters by ascent, which is excellently calculated for freeing it from every sort of impurity. If a greater supply of water at this well were necessary for the valuable purpose of turning machinery of any sort, or for any other such use, it might certainly, it is said, be obtained after the rate of several hundred gallons in the minute, by continuing to clear out the sand until the

obstruction it affords should become of little consequence; but, in this case, the quality of its water is of more importance than the quantity. The water, in this instance, is now had in a very high state of purity, as the originally excellent water, rendered so by flowing in a stratum or body of clear sand, is further purified and improved by filtering by ascent through many feet in thickness of the same material.

Other circumstances have occurred in digging and forming wells in different situations. It is stated in the Rural Essays, that in sinking a well at Sheerness, near the mouth of the river Thames, sometime since, some extraordinary phenomena or appearances occurred, many of which were deemed, by different persons, rather of a wonderful kind. They were these: that first is placed upon a neck of land, very little elevated above the surface of the sea. In digging the well, they passed first through a bed that consisted wholly of sand to the depth of thirty feet, the whole of the water found in which was of a salt taste, when at that depth they discovered a spring of salt-water, which, not being irresistibly abundant, they found themselves enabled to wall out; which being accomplished, they then sunk further, through a bed of clay for some fathoms more. They here found another spring of salt-water, as before; which having walled out in a similar manner, they continued to dig through the same bed of clay, for three hundred feet more; at the bottom of which they found a bed of gravel, from which issued a copious stream of fresh water, which soon filled the well within five feet of the top; at which height nearly it has ever since remained.

Extraordinary as these circumstances may appear, they are perfectly explicable on the principles and appearances which take place in boring and tapping springs. The fresh water, in this case, being confined and pent up at a very great depth in the earth, by impervious beds of materials, when the gravel or porous stratum that contained the water was sunk down into it, was forced up and rose, of course, to the height of the internal source or reservoir from which the water originally came in the distant high ground. If the spring in this instance should afford more water than is taken from the well, it will continue always about the above height; so that the water can only sink in the top of the well, when more is drawn from it than the spring can supply in a given time. See TAPPING Springs.

The springs of salt-water in this case are capable of being explained on the supposition of fissures or openings having been formed by the working of some sort of animal, or other unknown cause, so as to have penetrated the bed of clay, from the edge next the sea to some distance, as far inward, at least, as the opening of the well; through which, of necessity, salt-water would flow into the well as soon as it was opened. See Philosophical Transactions, vol. 74.

Another instance of a somewhat similar kind, though less complicated, as being divested of the circumstance of the salt-water, is mentioned to have taken place at Derby, under the direction of a late eminent physician and philosopher. A well was sunk in that place, which lies in a bottom, surrounded by many different hills; in which, after digging through a bed of clay for some considerable depth, an abundant spring of fresh water was found, which, as in most cases of this nature, rushed up with great impetuosity, and soon filled the well to the top, where it flowed over in a pretty full stream. This was instantly seen, and conceiving that it probably descended through some narrow subterraneous passage, from a height greater than that of the houses of the town, readily imagined that if the sides of the well could be raised to a sufficient height, making them at
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the same time strong enough to bear the pressure of the water within, it might be conveyed by this means to the highest floors of the houses; which was actually effected to the great convenience and advantage of the family.

The same circumstances might be taken advantage of in many other situations and cases, with equal benefit and convenience in this way, and still more in many others, especially in the turning of machinery.

Even the situation of the metropolis itself is said to afford a strong example in elucidation of the same general principle. It is well known that this is every where built upon a solid bed of clay, that extends to a great depth, and which lies above a large basin of water there confined and pent in, that can in no way be let off or discharged; in consequence of which, it is with certainty known, that water may be found by sinking a well in any place; and that the well-diggers are become so expert, that they can with little difficulty tell, until within a few feet of the depth to which the well must be sunk before water be found. They know, too, that when the water is found, it always rises in the well until it reaches a certain height, where it remains stationary ever after, never rising or falling scarcely more than an inch from its level under any diversity of season: and if the workmen be permitted to take their levels from a known point, they can tell, before they begin to dig, the precise length of pump that will be required to raise the water to the surface.

Thus, if a well be sunk in one of the lowest situations in the city, as about Fleet-market, and it should be found that it there requires to be dug forty feet before water is met with, and that the well makes a sort of drawing or tapping, the water will rise in the well to the height of a certain level, where it will, of necessity, become stationary, which is at the height of about ten feet from the surface of the ground. If in St. Paul's church-yard, which by a careful level has been found to rise fifty feet above the former situation; the well in this place will require to be sunk about ninety feet before it reaches the water, and that the water will rise to the certain level, and no higher; so that there the water will require to be lifted fifty feet to reach the surface of the ground. If in a lower part of the town, as about Aldgate and Fenchurch-street, the water there is found at sixty feet, and will rise to within thirty feet of the top. If about Thames-street, and its continuations near the river, the depths to which the wells must be dug, and the distance from the surface of the ground to the water will be rather various: in some cases, the water would rise within three or four feet of the surface, and in low places, run over the top. The depth of digging will be mostly much less than in the last case before the water is reached.

A case, which is strikingly illustrative of wells where they flow over the tops, is recorded by the above writer, as having also lately occurred in the vicinity of the metropolis. A gentleman bought a house and farm a little beyond Kensington gravel-pits, on the right-hand side of the road, nearly opposite to Holland-house. The premises were entirely destitute of water, which appeared to the occupier to be so great an inconvenience, that he determined to try if he could find any there by sinking a well, and resolved, rather than not succeed, to go to a very great depth. He began digging, and went down very far without discovering any symptoms of water; but not discouraged by this circumstance, he still proceeded. At length, when he had gone very deep, he found water, and was infinitely more fortunate than he expected; for he feared that after he had found water, it would be necessary to raise it by artificial means from so great a depth, as must greatly enhance the price of

it. The water, however, rose in the well very quickly till it reached the top, and there it ran over in a very copious stream, overflowing the field around it, till it found out a level for itself, forming a living rill, that continues to flow at all times of the year. The owner of the ground, after having made of it a fine piece of water for his pleasure, and supplied all his building with it abundantly, made that part of it issue through a pipe into a stone basin by the road side, for the accommodation of passengers of every sort; where it still continues to flow, running from thence along the ditch to the bottom of the eminence on which it stands; the surplus water from the pond being conveyed off by another channel.

These cases of wells are still further illustrated and explained by the nature of what happens in sinking deep pits and shafts in many places for different purposes, and from the large bursts of internal waters which take place in many instances and situations. See QUARRIES, &c. *Draining of*, and *Spring-Draining*.

On the whole, the facts and statements which have been given above, may sufficiently explain and elucidate the manner in which water is supplied and obtained in the digging and forming of wells, as well as the nature and distribution of the strata by which it is conducted, contained, and forced up into them. However, in most cases, before the sinking of wells is undertaken or begun upon, the nature of the different circumstances of the particular cases should be well and fully inquired into and considered, and the probability of success coolly and maturely weighed from a nice examination of the different springs and wells in the immediate neighbourhood; as where this is not the case, much labour, trouble, and money, may often be expended to little or no purpose, and great disappointment be sustained.

WELL-Digging, the art of sinking wells, and lining them with stone or brick, that they may preserve their figure; as this operation is necessary for wells in all soils except rock. There are two methods of building the stone or brick within the well, which is called the steining. In one of these a circular ring is formed, of the same diameter as the intended well; and the timber of which it is composed is of the size of the brick-courses, with which the well is to be lined. The lower edge of this circle is made sharp, and shod with iron, so that it has a tendency to cut into the ground; this circular kirb is placed flat upon the ground, and the bricks are built upon it to a considerable height, like a circular wall. The well-digger gets within this circle, and digs away the earth at the bottom; the weight of the wall then forces the kirb, and the brick-work with which it is loaded, to descend in the earth, and as fast as the earth is removed it sinks deeper, and the circular brick-wall is increased or raised at top as fast as it sinks down; but when it gets very deep, it will sink no longer, particularly if it passes through soft strata: in this case, a second kirb of a smaller size is sometimes began within the first.

When a kirb would not sink from the softness of the strata, or when it is required to stop out water, the bricks or stones must be laid one by one at the bottom of the work, taking care that the work is not left unsupported in such a manner as to let the bricks fall as they are laid: this is called under-pruning.

Well-diggers experience sometimes great difficulty from a noxious air which fills the well, and suffocates them if they breathe it.

The usual mode of clearing wells of noxious air, is by means of a large pair of bellows and a long leathern pipe, which is hung down into the well to the bottom, and fresh air is forced down to the bottom by working the bellows.

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This is intended to displace the damp air or gas, but is not very efficacious, because the damp air is of a greater specific gravity than pure air; so that ten gallons of fresh air is perhaps blown into the well, before two gallons of noxious air is displaced: and this probably happens because the atmospheric air is specifically lighter than the noxious air, and ascends through the latter to the top of the well, displacing but a small quantity of it. Such bellows, &c. are seldom to be procured on the spot when wanted, and are too weighty and cumbersome to carry about. If water is thrown down in a shower, it will sometimes clear the air; but this is laborious, in a deep well, to draw it up again.

The following apparatus may be used with great success in such cases; and as with fifty feet of pipe its weight amounts only to thirty pounds, it may easily be carried to any distance. Tubes of every kind being perpendicularly situated, and having their internal air rarefied, cause a current or stream of air to ascend through them. Suppose six lengths of metal pipe, each eight feet long, and two inches diameter, all made of tin plate, except the upper one, which is of copper, the better to bear the heat; let a cylindrical vessel be also made of copper, holding about two gallons, fixed fast to the upper pipe, and having through the sides of it a number of holes to admit air for the support of the fire, which is kindled within it. The vessel must be so fixed as to have at least five feet of pipe above its top.

The method of placing it in the well is, first, to lower down the bottom length, into the upper end of which, the lower end of the second length is joined, passing a wire through both to prevent their drawing apart again in holes made for that purpose; then fill the joint round with oil-putty, so as to render it air-tight. The upper end of each length of tube is wired, to prevent bending; which wiring also forms a receptacle for the putty. Then proceed in the same manner, with the remainder of the pipes, until the bottom one nearly reaches the surface of the water, but not quite. The fire-pan is to be supported on two timbers, placed for that purpose across the top of the wall, and a conical cover may be fitted over it to prevent the heat from passing away too rapidly, and to confine it to the sides of the pipe. The apparatus being thus fixed, it soon becomes filled with air of the same quality as that in the well; and as their power of gravity is the same, both the external and internal air become stationary, from which there can be no good effect. To put the experiment into execution, fill the fire-pan with lighted charcoal or wood, &c. the copper-pipe which is surrounded by the fire, being by this means heated, a rarefaction of the internal air takes place, which air by this means is lightened, and the external dense air, continuing to press with the same weight as first into the bottom of the tube, the equilibrium is destroyed, and a succession of noxious air passes up through the pipe, as through the funnel of a chimney, till the whole quantity is carried off; after which the pure air, which has in the meantime introduced itself into the well, begins to pass off by the same passage so long as the fire is continued, though the stream of air passing out of the top of the vertical-pipe seems small, yet the effect is great, because that stream consists entirely of noxious air that is required to be removed. The effect will be greater when the fire-pan is placed lower on the pipe, as by that means more external air becomes rarefied; but if the fire-pan is placed too low down in the well, the charcoal fire produces carbonic acid gas in great quantities, and renders the air in the well unfit for respiration.

WELL, in *Agriculture*, a term sometimes applied to a sort of pipe-chimney or vent-hole left in a stack, rick, or

mow of hay, or other similar materials, in order to prevent its being overheated. Such vent-holes should be avoided as much as possible in all cases, as injuring and destroying much hay about them, and being hurtful in other ways. See *STACKING Hay*.

WELLS, *Ebbing and Flowing*, in *Rural Economy*, such as have their waters rising and falling in an almost momentary alternate manner. See *SPRING*, and *WELL*.

WELLS, *Farm or Field*, in *Agriculture*, such as are dug in these situations for the use of live-stock.

Wells of this sort are of much use and convenience, as they prevent the trouble and disadvantage of driving cattle to distances for the purpose of getting water. See *POND*.

WELL, in the *Military Art*, denotes a depth which the miner sinks into the ground, from which he runs out branches or galleries, either to prepare a mine, or find out, and disappoint, the enemy's mine.

WELL, in a *Ship*, an apartment formed in the middle of a ship's hold to inclose the pumps, from the bottom to the lower deck. It is used as a barrier to preserve those machines from being damaged by the friction or compression of the materials contained in the hold, and particularly to prevent the entrance of ballast, &c. by which the tubes would presently be choaked, and the pumps rendered incapable of service. By means of this enclosure, the artificers may likewise more readily descend into the hold, in order to examine the state of the pumps, and repair them as occasion requires. *Falconer*.

WELL of a *Fishing Vessel*, an apartment in the middle of the hold, which is entirely detached from the rest, being lined with lead on every side, and having its bottom pierced with a sufficient number of small holes, passing also through the ship's floor, so that the salt-water running into the well is always kept as fresh as that in the sea, and yet prevented from communicating itself to the other parts of the hold. *Falconer*.

WELL also implies in the same range, or even with a surface.

WELL-*Drain*, in *Agriculture*, that sort of vent or discharge for the wetness of land, which is constructed in somewhat the well or pit manner. See *WELL-Draining*, and *SPRING-Draining*.

WELL-*Draining*, that means of clearing lands from wetness which, in certain flat situations, is accomplished by making large deep pits or wells, and the constant or occasional use of suitable machinery. In the execution of the business of forming a draining well in loose ground, a strong wooden frame is necessary to be sunk, as the work of digging the well or pit proceeds; the sides of which being made, so as in the end to be sufficiently open or permeable, to admit the water to enter freely within it, and close enough to prevent grosser matters from interrupting the machinery; especially when of the mill kind. The size of the frame for this purpose must, consequently, be adapted and suited to the nature of the engine which is employed. The laves of a mill, it has been observed, would require a length of frame, which must necessarily be proportionally strong; but, that for a pump, a frame of inconsiderable expence would be sufficient; whether of wood or uncemented brick-work.

In this sort of draining, which is applicable in many cases of cold wet flat lands lying in the valley-tracts in most parts of the country, the wetness is drawn off by these sorts of powerful machinery, working in the spring time, after wet seasons, or at other periods when necessary or wanted. See *SPRING-Draining*.

WELL-*Grown*, in *Ship-Building*, implies, that the grain of the wood follows the shape required, as in knee-timbers, &c.

WELL-

WELL-Hole, in *Building*, is the hole left in a floor, for the stairs to come up through. See **STAIRS**.

WELL-Room, of a *Boat*, denotes the place in the bottom where the water lies, between the ceiling and the platform of the stern-sheets, from whence it is thrown out into the sea with a scoop. Falconer.

WELL-Water. See **WATER**.

WELLAND, in *Geography*, a river of England, which passes by Stamford, Market Deeping, Spalding, &c. and empties itself into the German sea, in what is called "The Wash," between the counties of Lincoln and Norfolk.—Also, a river of Canada, which runs into the Niagara, between lake Erie and lake Ontario.

WELLE CORONDE, *Sandy Cinnamon*, a name given by the Ceylonese to a species of cinnamon, which feels hard and gritty between the teeth, as if it were full of particles of sand, though in reality there is no sand among it.

The bark of this tree comes off very easily: but it is not so fit to roll up into quills as the right cinnamon, for it is more rigid and stubborn, and apt to burst open. It is of a sharp but bitterish taste. The roots of all the cinnamon trees yield more or less camphor, but this as small a quantity as any of them. Phil. Trans. N^o 409.

WELLES, in *Geography*. See **WELLS**.

WELLESCHIN, a town of Bohemia, in the circle of Bechin; 10 miles S. of Budweis.

WELLESMITZA, a town of Servia, on the Danube; 10 miles S.E. of Orsova.

WELLFLEET, a township of Massachusetts, in the county of Barnstable, containing 1402 inhabitants, with a large harbour near Cape Cod. The inhabitants own 25 vessels, from 30 to 100 tons, employed in the whale, cod, mackarel, and oyster fishing; 60 miles by water S.E. of Boston.

WELLFLEET Bay, a bay of the state of Massachusetts, on the E. side of Cape Cod Bay.

WELLIA TAGERA, *H. M.* in *Botany*, a siliquous plant of Malabar, with a pentapetalous flower, and long flat pods, with transverse partitions between the contained seeds. It grows to the ordinary height of a man, with a stem as big as a man's arm, and is transplanted into gardens only on account of its beauty. It is an evergreen.

All the parts of this plant, the root excepted, are exhibited, with an addition of cummin, white sugar, and milk, against a virulent gonorrhœa. The leaves boiled in cow's milk, or used in baths, expel the gout. The bark, triturated with sugar and water, is proper for the diabetes. The bark of the root, and green saffron mixed with milk, give relief under the nodous gout, called by the Malabarians *sonida badda*. Raii Hist. Plant.

WELLIBALDSBURG, *St.*, in *Geography*, a town and citadel of Bavaria, in the bishopric of Aichstat, near Aichstat.

WELLIN, a town of Bohemia, in the circle of Koniggratz; 16 miles S.W. of Biezow.

WELLINGBOROUGH, a market-town in the hundred of Hamfordhoe, and county of Northampton, England, is principally situated on a red sand-stone rock, of which material the houses are generally built. The town is disposed along the slope of a hill, nearly a mile to the north of the river Nen, 11 miles N.E. by E. from the county-town, and 68 miles N.N.W. from London. It appears to have been of some note in the Saxon times, when a great part of it was destroyed by the Danes. After the Norman Conquest, it occurs among the numerous possessions annexed to the abbey of Croyland, in Lincolnshire; and at the suit of the monks of that house, was constituted a market-town, by

a charter from king John. In July 1738, it is stated, that about eight hundred dwelling-houses, besides outhouses, &c. were consumed by fire. A new town has been raised, and now assumes a much more respectable appearance than before the conflagration. The church is a spacious edifice, having at its west end a tower, surmounted by a spire: the roofs of the aisles, chancel, and chantry chapel, are decorated with various carved work; and on each side of the chancel are three stalls similar to those in cathedral choirs: the eastern window is richly ornamented with tracery, and sculpture in stone. This church had a guild to the honour of the Blessed Virgin; the revenues of which fraternity were, in the second year of Edward VI., appropriated to the erection and endowment of a free grammar-school. Here are also a large charity-school, and two meeting-houses for the public worship of Independent Dissenters. A weekly market is held on Wednesdays; and three fairs annually. The chief source of traffic is corn, the market for which is greatly improved by the decay of that of Higham-Ferrers, at four miles distance. Here is also a considerable manufacture of lace; as also of tammies, harrateens, and other worsted stuffs. In the population return of the year 1811, the inhabitants of this parish are enumerated as 3999, occupying 749 houses. About half a mile north-west of the town, in an open field, is a chalybeate spring, called Red-well, formerly much celebrated for its medicinal virtues: in the year 1626, king Charles and his queen resided here a whole season, for the benefit of drinking the water, pure from the source.—*Beauties of England and Wales*, vol. xi. Northamptonshire; by the Rev. J. Evans, and J. Britton, F.S.A. *Bridges's History of Northamptonshire*, 2 vols. fol. 1791.

WELLINGTON, a large market-town in the hundred of Kingsbury West, and county of Somerset, England, is situated on the borders of Devonshire, at the distance of 20 miles W.S.W. from Somerton, and 149 miles in the same bearing from London. The earliest historical account of it commences with the reign of Alfred, who bestowed the manor on Asser, who had been tutor to several of his children, and was afterwards advanced to the see of Sherborne, and died possessed of that dignity, in the year 883. After his death, the king granted the manor to the first bishop of Wells, for the support of the episcopal honours of himself and his successors. It continued annexed to that see, till the reign of Edward VI., when it became the property of the duke of Somerset by purchase from bishop Barlow. The town consists of four streets, the principal of which, called the High-street, is very wide and spacious; the houses are in general well built and commodious. It is a place of considerable trade: the chief articles manufactured here are, ferges, druggets, and pottery. A weekly market, on Thursdays, is well supplied with all kinds of provisions; and two fairs are annually held. According to the population return of the year 1811, the parish contained 755 houses, and 3874 inhabitants, of whom 565 families were stated to be employed in trade and manufacture. The church is a spacious structure, consisting of a nave, chancel, two aisles, and two small chapels. At the west end is a fine embattled tower, a hundred feet in height, decorated with twelve pinnacles of excellent workmanship. In the south chapel is a magnificent tomb in honour of sir John Popham, lord chief justice of England, in the reign of queen Elizabeth. On the table of this monument are the effigies of sir John and his lady, under an arched canopy, richly ornamented with the family arms, roses, paintings, and obelisks. The whole is supported by eight columns of black marble, five feet high, with Corinthian capitals, green and gilt. Sir John was a munificent patron to Wellington:
among

among other benefactions, he erected an hospital for six men and six women, being old and infirm; two children were also to be educated here. This edifice is still standing: fir John endowed it with an estate in land, which is vested in governors, and properly applied.—*Beauties of England and Wales*, vol. xiii. *Somerfetshire*. *Collinson's History of Somerfetshire*, 3 vols. 4to. 1791.

WELLINGTON, a small market-town in the Wellington division of the hundred of Bradford, and county of Salop, England, is situated near the Wrekin-hill, at the distance of 12 miles E. by S. from Shrewsbury, and 151 miles N.W. from London. It is neatly built, and contains many good houses. The market, which is held on Thursdays, is well supplied, and much frequented; and here are three annual fairs. The church, which has been lately rebuilt, is supported on cast-iron pillars, and the window-frames are of the same material, which gives a lightness to the edifice: one of the frames is fifteen feet in height. Near the church is a very respectable charity-school. In this town and its vicinity, at the commencement of the civil war, king Charles, then on his march to Shrewsbury, mustered his forces, and after issuing orders for the observance of strict discipline, made a solemn protestation that he would defend the established religion, govern by law, and preserve the liberty of the subject; and that if he conquered he would uphold the privileges of parliament. The parish of Wellington includes, besides the town, six townships. The return of the year 1811 states the population to be 8213; the number of houses 1724. The chief employment of the inhabitants is in the coal-works; here are also some mines of iron-ore. About two miles southward from the town is the Wrekin, a stupendous mountain 1100 feet in height. Through the adjacent country runs the Roman road called the Watling-street.

Beneath the Wrekin, and adjoining the road leading to Shrewsbury, is Orleton, the seat of William Cludde, esq. of an ancient family in this county. The mansion at present has a modern appearance, but is of very great antiquity, and till of late was enclosed with walls and a gate-house, and was surrounded by a moat.—*Beauties of England and Wales*, vol. xiii. Salop; by J. Nightingale, and R. Ryland, 1811.

WELLINKOVEN, a town of Germany, in the county of Mark; 6 miles W. of Schwitz.

WELLOE, (THE,) a rock in the English channel, near the coast of Cornwall; 9 miles S.E. of Penzance. N. lat. 5°. W. long. 5° 14'.

WELLS, WILLIAM CHARLES, F.R.S., I. and E., licentiate of the Royal College of Physicians, London, and one of the physicians to St. Thomas's Hospital, in *Biography*, was the son of parents who left Scotland and settled in Carolina, in 1753, and born in Charlestown, South Carolina, in May 1757. Few lives have been more diversified by incident and more sedulously devoted to literary and scientific pursuits, and therefore more entitled to notice in our biographical sketches than the subject of this article. Before he had attained the age of seven years, he was sent to a considerable grammar-school at Dumfries, where he remained nearly two years and a half; and in the autumn of the year 1770 he removed to Edinburgh, and attended several of the lower classes of the university. At this early age he had the good fortune to become acquainted with Mr. David Hume and sir William Miller, now known by the title of lord Glenlee, whose friendship he afterwards cultivated and valued, and whose kind offices he gratefully acknowledged. In 1771 he returned to Charlestown, and was apprenticed, in the medical profession, to Dr. Alexander Garden, whose name is well known among naturalists; and during three years of the

time he was with this gentleman, he pursued his studies with such diligence, that he acquired perhaps more knowledge than in any three subsequent years of his life. Soon after the commencement of the American war, in 1775, he came to London. The occasion of his removal was his refusal, from conscientious motives, to sign a paper denominated "The Association," which was drawn up in order to unite the people in a resistance to the claims of the British government. At the commencement of the winter of that year he went to Edinburgh, and entered upon his medical studies, with the view of taking a degree. To his former two friends, with whom he had kept up a regular correspondence, he had now the happiness of adding a third, no less intimate and constant than the others, the present Dr. Robertson Barclay. Having pursued his studies for three winters, and passed his preparatory trials in the summer of 1778, he left Edinburgh without graduating, and returned to London, where he attended a course of Dr. William Hunter's lectures, and became a surgeon's pupil at Bartholomew's hospital. In 1779 he went to Holland as surgeon to a Scotch regiment, in the service of the United Provinces; but receiving offensive treatment from the commanding officer, he resigned his commission, and challenged the aggressor, under the unjust charge of military insubordination, for which an attempt was made to punish him; but without receiving the satisfaction which he demanded, he went to Leyden in the beginning of the year 1780, and there prepared an inaugural thesis on the subject of "Cold," which was published at Edinburgh in the close of that year, on occasion of his taking the degree of doctor in medicine. At this time he commenced his acquaintance with Dr. Lister, a gentleman no less distinguished for his integrity and liberality than for his skill in his profession; and it redounds in no small degree to the honour of Dr. Wells, that their friendship continued without interruption till his death. Nor was it less honourable to both these gentlemen, that they were introduced to an acquaintance with each other by their common friend Dr. James Currie, the author of "Medical Reports," and the biographer of Burns; whose premature death was lamented by all who knew him, and were duly apprized of the eminent rank which he occupied in the medical profession. In the beginning of the year 1782 Dr. Wells visited Carolina, then in the possession of the king's troops, for the purpose of arranging the affairs of his family; and whilst he was there, he sustained a variety of offices, seemingly very incompatible with each other, and which no person destitute of his versatile talents and peculiar activity could have satisfactorily performed. He was an officer in a corps of volunteers, a printer, a bookseller, and a merchant, a trustee for the management of the affairs of some of his father's friends in England, and on one occasion a judge-advocate. In December 1782, when the king's troops were obliged to evacuate Charlestown, he removed to St. Augustine, in East Florida, and there edited the first weekly newspaper that had been published in that country, having brought with him a printing-press, which had been taken to pieces for the convenience of carriage, and which he contrived, with the assistance only of a negro-carpenter, to refit for use. During his residence in Florida, he became captain of a corps of volunteers, and manager of a company of officers, who had agreed to act plays for the relief of the poorest of the loyal refugees from Carolina and Georgia, and occasionally an actor himself. In 1784 he removed from St. Augustine to London, and becoming acquainted with Dr. Baillie, commenced an intimate, steady, and affectionate friendship, the benefits of which he experienced till his death. Having spent three months at Paris in the year 1785, he returned to London in
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the autumn of that year, and settled as a physician in this city. His father had resided in London from the commencement of the American war, and had amassed a fortune of 20,000*l.*; but by misfortunes in trade his circumstances were now embarrassed, so that Dr. Wells, at the outset of his profession, was obliged to raise money by loans, amounting to 600*l.* For the first few years after settling in London he scarcely took a fee, and after having been engaged for ten years in the exercise of his profession, his receipts from every source did not amount to 250*l. per annum.* However in the next five years he was able to pay part of his debt, and before his death he had the satisfaction of having paid the whole of it, both principal and interest; and it should be mentioned to his honour, that when his income was very limited, he allowed an annuity of 20*l.* to a poor relation.

In 1788 he was admitted a licentiate of the Royal College of Physicians in London; and he took part with those who asserted their eligibility and right of admission to the class of fellows. After the decision of this claim in the court of king's bench, he applied in 1797 for examination, so that if he were found to be fit, he might be returned a fellow. But this application was unavailing; and yet about four years before his death the president of the college sent him a message, expressing a wish to know if he had any desire to become a fellow; to which he replied in the negative. In 1790 he was appointed a physician to the Finsbury Dispensary, in which connection he remained till the year 1798. In 1793 he was chosen a fellow of the Royal Society; and in 1800 he became physician of St. Thomas's hospital, having been assistant physician from the year 1798. In the year 1800 he was seized with a slight fit of apoplexy; but by adopting a very abstemious mode of living, he escaped any subsequent attack. From this time, however, his health declined.

In 1812 he commenced some experiments on dew, and after he had an opportunity of pursuing them, he wrote an "Essay" on the subject, which was published in August 1814, the year in which he was admitted into the Royal Society of Edinburgh; and in 1816 the Royal Society of London adjudged to him the honour of the gold and silver medals of count Rumford's donation for this essay. Although from the year 1814 to the commencement of his last illness his health was in some respects improved, he was afflicted with painful and threatening symptoms. These symptoms became gradually more alarming; and though in his last illness some hopes were entertained by his medical friends, Dr. Baillie and Dr. Lister, of his recovery, yet on the 8th of August he was suddenly seized, while he was sitting up, with the sensation of a tremulous motion in the chest, which he referred to the heat, from which time his illness intermitted. "After this," says his biographer, "an expectation was entertained of his recovery: His life was continued until the evening of the 18th of September 1817; and until the near approach of its termination, his mind was clear and active, and his spirits calm and cheerful."

Our limits will merely allow our enumerating his principal publications. Of his political papers we shall only mention one, which was written in 1781, by the desire of the commandant of the garrison of Charlestown, general Nesbit Balfour. The object of this paper was to shew, by military usage, and the nature of the case, that persons in the American service who, after having been taken prisoners and sent to their homes under their military paroles, and who appeared again in arms against the British government, subjected themselves to the punishment of death. This paper was frequently published in the newspapers, and it is pro-

bable that it was owing to this publication that general Balfour and lord Moira thought themselves justified in putting to death a colonel Haynes, the propriety of which act was afterwards a subject of debate in the British parliament. The philosophical pieces of Dr. Wells were the following: *viz.* "An Essay upon single Vision with Two Eyes," 1792, (see VISION, in the Addenda); "Two Letters, in reply to Dr. Darwin's Remarks in his Zoonomia upon what Dr. Wells had written in his Essay upon Vision, on the apparent Rotation of Bodies which takes place during the Giddiness occasioned by turning ourselves quickly and frequently round," 1794, contained in the Gentleman's Magazine for September and October; "A Paper upon the Influence which incites the Muscles to contract in Mr. Galvani's Experiments," 1795; "Experiments upon the Colour of the Blood," 1797; "Some Experiments and Observations on Vision," 1811; all published in the Philosophical Transactions. "An Essay upon Dew," 1811. In this essay the author has introduced new facts and ingenious observations, of which we shall give some account in our additions to the article DEW. "An Answer to Remarks in the Quarterly Review upon the Essay on Dew," and "An Answer to Mr. Prevost's Queries respecting the Explanation of Mr. B. Prevost's Experiments on Dew," 1815; "A Letter to Lord Kenyon relative to the Conduct of the Royal College of Physicians of London, posterior to the Decision of the Court of King's Bench, in the Case of Dr. Stanger;" "A short Letter on the Condensation of Water upon Glass," 1816; which three last appeared in Dr. Thomson's *Annals of Philosophy*. "Some Biographical Sketches by Dr. Wells" appeared in the Gentleman's Magazine.

Almost all his writings upon medical subjects are contained in the second and third volumes of the Transactions of a Society for the Promotion of medical and surgical Knowledge: and their subjects are,—erysipelas; the entire want of hair in the human body; the dropsy, which succeeds scarlet fever; aneurism of the aorta attended with ulceration of the œsophagus and wind-pipe; epilepsy and hemiplegia, apparently produced by a sharp projection from the inner table of the skull; tetanus; aneurism of the aorta, communicating with the pulmonary artery; enlargement of the cæcum and colon; gangrene of the cellular membrane between the muscles and skin of the neck and chest; rheumatism of the heart; red matter and serum of the blood in the urine of dropsy, which has not originated in scarlet fever; and observations on pulmonary consumption and intermittent fever, chiefly as diseases opposed to each other, &c.; to which may be added, a case of aphonia spasmodica, in the second volume of *Medical Communications*. His manuscript papers were directed to be destroyed, with the exception of one, relating to the difference of colour and form between the white and negro races of men, which will be published.

The literary productions of Dr. Wells have sufficiently established his reputation as a learned and skilful physician, as an acute and inventive philosopher, and as a perspicuous, vigorous, and elegant writer; and it is said, that those who knew him personally estimated him much more highly than persons who were acquainted only with his writings. His mental powers were strong, acute, comprehensive, and versatile; and he was capable of the most close and long-continued attention, and of directing this attention at pleasure. Although he was not eminently distinguished as a classical scholar, or as a deep mathematician, he had read some of the Greek and most of the Latin classics with great attention; wrote Latin with facility and correctness; and made himself

master of the elementary books of the inferior branches of the mathematics. He was well acquainted with natural philosophy, and particularly optics, and also with the facts of modern chemistry; he was an acute metaphysician, and intimately versed in the theories of morals and politics, in ancient and modern history, commerce, and political economy; he had successfully studied belles lettres, and was familiar with the best writers in the English language; and his own style was pure, perspicuous, and occasionally forcible and elegant. In conversation he was instructive and interesting; and in active life prompt and decisive, and at the same time prudent and cautious. In his habits and manners, he was indefatigable in his application; frugal, and yet as far as his circumstances would allow liberal; high-minded, but sensible of obligation and grateful for kindness; resentful, yet placable; irascible even on trivial occasions, but exercising self-command under great provocations when the importance of circumstances and propriety required it; indignant at insolence and oppression, and regardless of all personal consequences in expressing his resentment, but submissive to the appointments of heaven, and calm and cheerful under the sufferings which flowed from them. "A sense of duty," says his biographer, "was the paramount feeling of his mind, to which other passions gave way, and which danger and difficulty served only to make more active and vigorous." Such is the tribute which has been evidently dictated by a friend; and yet we have reason for being assured that it is, upon the whole, such as the merit of Dr. Wells justly claimed. *Gent. Mag.* for November 1817.

WELLS, in *Geography*, a city of Somersetshire, England, is situated in the hundred of Wells-forum, at the distance of 18 miles from Bath, 21 miles from Bristol, and 121 miles W. by S. from London. It is said to owe its origin to a remarkable spring called St. Andrew's well, the waters of which were supposed to possess extraordinary medicinal properties. These are recorded to have been highly beneficial to Ina, king of the West Saxons, whose religious zeal therefore prompted him to found a collegiate church here in the year 704, and which he dedicated to the above saint. This church was converted into a cathedral in the year 905, when three new bishoprics were constituted by order of king Edward the elder, and Wells was then made an episcopal see. This was afterwards transferred to Bath by bishop Villala, about the end of the eleventh century, who built a palace there, and assumed the title of bishop of Bath. Great contentions soon arose between the two chapters of Bath and Wells, respecting the right of election to the episcopal office. The matter being referred to the arbitration of the bishop himself, it was determined that his successors should take their title from both churches; that an equal number of delegates from both chapters should enjoy the privilege of voting, and that the installation should take place in both cathedrals. This regulation, which was made by bishop Robert, about the year 1135, continued until the reign of Henry VIII., when an act of parliament was passed for vesting the power of election solely in the dean and chapter of Wells. Henceforward the cathedral and episcopal seat have been fixed at Wells, but the title of the bishop is of "Bath and Wells." To the pious zeal of its bishops, the city is indebted for that truly interesting structure, its cathedral church. The building of king Ina having, in the course of four centuries, fallen into a dilapidated state, was about the year 1150 rebuilt on a much larger scale by its bishop. In 1239 it received considerable additions by bishop Joceline, who altered, or fitted up the choir, and made other improvements; the south-west tower was added by bishop

Harewell, and other contributors, in 1366; in 1415 the north-west tower was raised by bishop Bubwith; and finally, the chapel of the Virgin Mary was added by bishop Beckington, about the year 1445. Other parts of this interesting fabric were erected and adorned by other prelates, but the precise time of these alterations is not recorded. The cathedral, as it now appears, consists of a nave, with two aisles, a transept, and choir, also with side-aisles; at the eastern extremity of the choir is a smaller transept, and the chapel of the Virgin; on the north side is a porch, also a covered passage to the chapter-house and deanery. Over the intersection of the nave and transept is a large quadrangular tower, 160 feet in height, resting on four broad arches, and at the west end are two other towers. The length of the nave is 190 feet; of the choir to the altar, 108; and of the chapel of the Virgin, 52 feet. The whole fabric exhibits specimens of the different styles of architecture which prevailed between the twelfth and fifteenth centuries; but the most interesting part is the west front, certainly one of the most imposing examples of architectural and sculptural workmanship in the kingdom. It is adorned with a great number of niches and canopies, with statues of the apostles, popes, princes, bishops, &c. It is divided into five portions in height by bold buttresses, and four decided compartments, horizontally. In the centre is a large entrance door-way to the nave, over which are three tall lancet-shaped windows; above these is a pyramidal façade to the gable of the roof, crowned with pinnacles, and adorned with numerous niches, statues, &c. The buttresses are likewise covered with panelling, tabernacles, and statues. The interior of the church is full of interest and beauty. Its nave consists of nine clustered columns on each side, supporting pointed arches, over which is a triforium, or open gallery. A third story above this displays a series of windows, which, with the other arches, are mostly of the lancet-shape. The columns, cross-springers under the roof, and the whole architecture of this part of the church, display the style of the early part of the thirteenth century. In the nave are two elegant monumental chapels, or oratories, to the respective memories of bishops Bubwith and Knight. Adjoining the latter is a curious stone pulpit. At the intersection of the nave with the transepts is a large central tower, which rests on four solid piers, or clustered columns, sustaining four arches, and over which are inverted arches. The choir is richly ornamented, and lighted by six highly pointed windows on each side, and a large eastern window over the communion-table. Behind the latter are three open arches to the lady chapel, which is singular in form, decoration, and character. Immediately behind the altar is a circular arrangement of columns, east of which is an absis, forming a half octagon. The whole is surrounded by large windows, with painted glass. In this part of the church are several curious and interesting monuments. North of the great transept is the chapter-house, an octangular apartment, in the centre of which is a lofty clustered column, from which diverge several ribs.

Southward from the cathedral is the episcopal palace, which has more the appearance of a fortified castle than of the residence of a bishop. It is surrounded by a wet moat, an embattled wall, flanked with semicircular turrets, with a venerable gate-house on the north side. The deanery-house is a spacious quadrangular building; and here are good houses for the prebendaries. The establishment of the cathedral consists of a bishop, a dean, twenty-seven prebendaries, nineteen minor canons, a precentor, treasurer, chancellor, and three archdeacons; a number which few other cathedrals have.

The city of Wells is seated in a valley, surrounded by lofty hills, and has some spacious streets. It was first made a free borough in the reign of Henry II., by the interest of Joceline, its bishop. It afterwards received a charter from king John, by which it was provided with a weekly market; by queen Elizabeth's charter, the corporation consists of a mayor, recorder, seven masters, and sixteen common-council men. Wells has sent two members to parliament from the earliest period: the right of election is in the mayor, masters, burgesses, and freemen. The voters are about five hundred; the mayor is the returning officer. By the return to the population act of the year 1811, the number of houses is stated to be 930; of inhabitants 5156. Six annual fairs are held here; and markets on Wednesdays and Saturdays. The corporation have a spacious town-hall for the dispatch of their business; where also the assizes are held. Under this hall is an hospital, founded by bishop Bubwith, for the maintenance of thirty poor men and women. Here are several other alms-houses, particularly those endowed by Nathaniel Steel and son, for thirty-two men and women, who are allowed three shillings each *per week*, with a great-coat for the men, and a gown for the women, once in two years. A charity-school was also erected here for twenty boys and twenty girls, in the year 1714.

Near the village of Wookey, which is situated about two miles north-west from Wells, is a remarkable cavern, called Wookey Hole. In its front is an assemblage of vast rocks, which rise to the height of at least two hundred feet, almost covered with trees and plants springing out of the fissures. On the left side of a deep ravine is a natural terrace, which leads to the mouth of the cavern, and through the middle of it runs a clear rapid rivulet, that rushes out of an arch thirty feet in height, and forty in breadth, impetuously making its way over an irregular bed of rocks. Hence, an opening not more than six feet high, conducts into a spacious vault, eighty feet in height, entirely covered with stalactites. Near this is a similar, though smaller vault; and beyond them, a low passage leads to a space nearly circular, and about one hundred and twenty feet in diameter, with a vaulted roof forty feet in height. Near this area is what the vulgar call the Witch's Brewhouse, where a great number of singular configurations of stalactite are observable, to which correspondent appellations have been given, such as the boiler, furnace, &c. To the left is what is called the hall, which is very lofty, the centre of the roof being at least one hundred feet above the ground. The whole length of the cavern is supposed to be six hundred feet.—Collinson's History of Somersetshire, 3 vols. 4to. Maton's Observations on the Western Counties, 1797. Davis's Concise History of the Cathedral Church of Wells, 1809.

WELLS, a township of New York, in Montgomery county, erected in 1805 from the N. part of Northampton and Mayfield, bounded N. by Franklin county, E. by Essex, Washington, and a small part of Saratoga county, S. by Northampton and Mayfield, and W. by Johnstown, about fifty-five miles long and eight miles wide. The country is rough and mountainous, and the soil light, sandy, and barren. It has numerous lakes and ponds, which abound with trout and other cold-blooded fish, affording good food as well as sport for the angler. Pezeeke lake bears the name of an Indian, and lake Pleasant is a pleasant lake, with a fine beach of white sand.

WELLS, a sea-port town of England, in the county of Norfolk, with a harbour at the mouth of a small river, of difficult access, on account of the shifting sands at the entrance. The chief trade is in corn, malt, and coals; and of late an oyster-fishery has been established: it has no market.

The population in 1811 was 2683. Near on the W. of Wells is Holkham-hall, the magnificent seat of T. W. Coke, esq. M.P. Wells lies 118 miles N.E. from London.—Also, a town of West Florida, situated on the W. side of St. Andrew's bay. N. lat. $30^{\circ} 25'$. W. long. $85^{\circ} 50'$.—Also, a town of America, in the district of Maine, and county of York, at the bottom of a bay to which it gives name, between Capes Porpoise and Neddik, containing 4489 inhabitants; 20 miles S.W. of Portland. N. lat. $43^{\circ} 20'$. W. long. $70^{\circ} 32'$.—Also, a town of Vermont, in the county of Rutland, containing 1040 inhabitants; 10 miles S.W. of Rutland.

WELLS, a river of Vermont, which runs into the Connecticut.

WELLS'S CREEK, a river of Kentucky, which runs into the Ohio, N. lat. $38^{\circ} 47'$. W. long. $84^{\circ} 27'$.

WELLS'S FALLS, a cataract in the river Delaware; 13 miles N.W. of Trenton.

WELLS'S PASSAGE, an inlet on the west coast of North America, branching off from Broughton's Archipelago.

WELMICH, or WELMENACH, a town of Germany, in the circle of the Lower Rhine, on the right bank of the Rhine; 1 mile from St. Goar.

WELMINA, a town of Bohemia, in the circle of Leitmeritz; 5 miles W. of Leitmeritz.

WELOVAR, a town of Croatia; 16 miles S.E. of Creutz.

WELP, a town of Bohemia, in the circle of Konig-ingratz; 3 miles S.E. of Toplitz.

WELPSHOLTZ, a town of Germany, in the county of Mansfield, memorable on account of a victory which Lothario, duke of Saxony, obtained over Henry V. in the year 1115.

WELS, a town of Austria, on the river Traun. This is supposed to have been an ancient town of the Norici, and by the Romans called *Ovilara*, or *Ovilaba*. Others say it was built by the emperor Valerian after his expedition against the Scythians in Pannonia. The emperor Maximilian I. died here; 11 miles S.S.W. of Lintz. N. lat. $48^{\circ} 10'$. E. long. 14° .

WELSBACH, a river of Thuringia, which runs into the Unstrutt, near Thomabruck.

WELSCHBILLIG, a town of France, in the department of the Sarre; 18 miles N.N.E. of Luxemburg.

WELSCHBIRKEN, a town of Bohemia, in the circle of Prachatitz; 6 miles N.N.W. of Prachatitz.

WELSE, a river of Brandenburg, which runs into the Oder, near Vierraden.

WELSH GLAIVE, or BILL, in *Military Antiquities*, a kind of bill, sometimes reckoned among the pole-axes, which was formerly much in use.

WELSHPOOL, anciently TRALLWNG, a large and populous market-town, partly in the hundred of Pool and partly in that of Cawrse, in the county of Montgomery, North Wales, is situated on the bank of the river Severn, 8 miles N. from the county-town, and 169 miles N.W. by W. from London. It consists of one long and spacious street, with another smaller, crossing it at right angles, and several other collateral branches of lesser dimensions; and is the largest and best-built town in the county. From the manners and language of the inhabitants, it has every appearance of an English town; the Welsh being spoken here by few persons. An air of urbanity and opulence pervades the place, chiefly owing to the intercommunication with the more polished parts of the kingdom, and to the extensive trade in flannels; great quantities of which are manufactured here,

here, and still greater brought from the hill countries. This being the principal mart for that article, a market is held on every alternate Monday for the sole purpose of exposing it to sale. A weekly market is also held on Mondays for provisions; and here are six annual fairs for horses, sheep, and cattle. The Severn becomes navigable at a small distance below the town, at a place called the Pool-stake; and a branch of the Ellesmere canal running near, tends to facilitate carriage by water conveyance. Among the recent improvements made in the town, is the county-hall, erected at the expence of a few private gentlemen. This structure, with a colonnade and pilasters of stone in front, consists of upper apartments for the administration of justice, and of lower ones for the accommodation of trade. Beneath is a spacious place, appropriated as a corn-market; a separate space for the sale of miscellaneous articles; and an ample court for holding the assizes or great sessions. On the second floor is the county-hall room; and a handsome room adjoining is fitted up for the use of the grand jury. The church, though in the pointed style, is apparently of no very remote antiquity. It stands singularly at the bottom of a hill, and is so low, that the ground of the cemetery almost equals the height of the building. Among the sacramental utensils is a chalice of pure gold, brought from Guinea on the coast of Africa, containing a wine quart: it bears a Latin inscription, stating that its intrinsic value was 168*l.*, and that it was presented to the church in the year 1562 by Thomas Davies, some time governor-general of the English colonies on the western coast of Africa. Welsh-Pool has a very ancient corporation: its original charter was granted by one of the princes of Powys Land, about the end of the eleventh century; the present was a grant from Charles II., by virtue of which the town is governed by two bailiffs, a high steward, recorder, and town-clerk; under whom are two serjeants at mace. The population of the parish, which includes nine adjoining townships, was in the year 1811 returned to parliament as 2779; the number of houses as 578. Formerly the town contributed with the borough of Montgomery in sending a member to parliament; but was disfranchised of this privilege in the year 1728. There are some encampments in this parish, one of which is said to have been the British camp of Caractacus, on the summit of the Bryddin-hill, where the last remains of ancient British liberty were lost by the surrender of that brave sovereign: on the centre of this mountain a column was erected, to perpetuate the memory of admiral Rodney's celebrated victory over the French fleet in the West Indies, April 12. 1782.

About a mile to the southward of Welsh-Pool, is Powys Castle, formerly the chief mansion of the Convinian Welsh princes of Powys, and now the residence of the earl of Powys. This venerable pile, situated in a well wooded park, is built in the ancient style of domestic architecture, participating of the castle and mansion. The entrance is by a gateway between two massy circular towers, into the area or court, round which the apartments range. Several other towers are still standing, flanked with semicircular bastions. In front, two immense terraces, rising one above another, form the ascent, by means of a vast flight of steps. The interior exhibits little worthy of notice, excepting the principal gallery, measuring 117 feet in length, which was originally much longer; but in the modernizing plan a large room has been taken from it. The park is formed of spacious lawns, and swelling hills; the oak, beech, and chestnut, diversify the views in rich variety; and highly contribute to render the place interesting to the lovers of forest scenery. It is, however, to be regretted, that this

venerable castle is verging to decay: the buildings are in a state of dilapidation; the gardens and grounds are neglected; and the pride and ornament of the park removing, for the sake of the timber: so that at no very distant period, the beauty and magnificence of Powys may be no more.—*Beauties of England and Wales*, vol. xvii. North Wales. By Rev. J. Evans, 1812.

WELSTEIN, a town of France, in the department of Mont Tonnerre; 7 miles E.S.E. of Creutznach.

WELSUN, a town of the duchy of Guelderland; 6 miles W. of Hattem.

WELT-ROOT, in *Agriculture*, a term that signifies the dying away or falling off of wheat-crops, in some cases, in the winter or early spring seasons. It has been supposed to occur the most frequently where the wheat-crops have been put in on clover leys. Some incline to think that it depends upon the want of a sufficient degree of closeness and firmness in the soils on the beds of mould into which the crops have been put; as where they lie too open and in too porous a state, due nourishment and support is not supplied to the young wheat plants from below, that, of course, they do not form their roots in a proper manner. See TREADING.

The term is also applied to an operation in the harvesting of grain. See ROOT-*Welt*.

WELTENBURG, in *Geography*, a town of Bavaria, on the right side of the Danube; 20 miles E.N.E. of Ingolstadt.

WELTERSBERG, a town of Germany, in the county of Lemingen; 1 mile S. of Welterburg.

WELTZENEN, a town of the duchy of Westphalia; 5 miles N. of Werl.

WELWARN, a town of Bohemia, in the circle of Schlan; 8 miles N.E. of Schlan. N. lat. 50° 18'. E. long. 14° 24'.

WELWIN, a village of England, in the county of Herts, where the general massacre of the Danes is said to have begun in 1012. In this place, Dr. Young, who was the rector, wrote his celebrated *Night Thoughts*. Here is a chalybeate spring; 25 miles N. of London.

WELZHEIM, or WELZEN, a town of Wurtemberg, and capital of a lordship to which it gives name, on the Lein; 20 miles E. of Stuttgart.

WEM, a market-town of Whitchurch division of the north part of the hundred of Bradford, in the county of Salop, England, is situated near the source of the river Roden, at the distance of 7 miles S. from the town of Whitchurch, 10 miles N.E. from Shrewsbury, and 172 miles N.W. from London. From its situation Horsley infers, that it is the site of the ancient Rutunium. The manor was formerly in the possession of the earls of Arundel, but on the attainder of earl Philip, in the reign of queen Elizabeth, it fell to the crown; and James II. conferred it on the lord chancellor Jefferies, of infamous memory, who had the estate, and was created baron of Wem. On his death, the title descended to his son; but on his decease, which occurred shortly after, it became extinct. The town of Wem consists of one large street, with a few smaller ones. By the population return of the year 1811, the number of houses was stated to be 297, and the inhabitants 1395. A weekly market is held on Thursdays, and three fairs annually. The church, a rectory of the real value of about 500*l. per annum*, is a handsome edifice, with a lofty tower, and a fine chancel. A free-school was founded and liberally endowed by sir Thomas Adams, who was born in this town in the year 1586, and was elected lord mayor of London in 1645. He was an inflexible adherent to king Charles I. in his troubles, and

continued

continued his attachment to Charles II. while in exile, to whom he is said to have made a remittance of 10,000*l.* On the eve of the Restoration he was deputed by the corporation of London to go with general Monk to Breda, to conduct the king to England. The munificence and charities of sir Thomas were exemplary: among other memorials, is an Arabic professorship founded by him in the university of Cambridge. He died February 24. 1667, in the 81st year of his age. Near this town, in 1640, was born William Wycherley, a celebrated dramatic writer, who died January 1. 1715. In the same house which gave him birth, was also born John Ireland, author of the "Illustrations of Hogarth," and otherwise well known in the literary world.—*Beauties of England and Wales*, vol. xiii. Shropshire. By Rylance, and J. Nightingale, 1811.

WEMBDINGEN, a town of Bavaria; 10 miles E. of Nordlingen. N. lat. 48° 51'. E. long. 10° 40'.

WEMBERG, a town of Bavaria, in the landgraviate of Leuchtenberg; 6 miles S.W. of Leuchtenberg.

WEMDALEN, a town of Sweden, in Hardjedalen; 107 miles W.N.W. of Sundswall.

WEMISTITZ, a town of Moravia, in the circle of Znaim; 4 miles S.W. of Krumau.

WEMMERBY, a town of Sweden, in the province of Smaland; 50 miles N. of Calmar.

WEMO, a town of Sweden, in the government of Abo; 22 miles N.W. of Abo.

WEMYSS, a sea-port town of Scotland, in the county of Fife, on the N. side of the Frith of Forth; a burgh of barony governed by bailies and a council: it has a good harbour, and several vessels belong to it, chiefly employed in the carrying trade. Coals and salt are the only exports; 4 miles N.E. of Kirkcaldy. N. lat. 56° 9'. W. long. 3° 4'.

WEMYSS, *Easter*, a town of Scotland, in the county of Fife, on the coast, but without a safe harbour: here are the ruins of a castle usually called Macduff's Castle, said to have been built by Macduff, who was created earl of Fife, in 1057, by Malcolm Canmore; 5 miles N.E. of Kirkcaldy.

WEN, in *Surgery*, an encysted swelling, the particular nature of which is described in the article TUMOURS. See also ATHEROMA, MELICERIS, and STEATOMA, which are technical names applied to the three principal varieties of encysted tumours. Scarpo's observations on encysted swellings of the eye-lids, will be found in another place. See EYE-LID.

WEN, in *Animals*, a fleshy substance growing out of any part of an animal's body, and which not unfrequently proceeds from blows, bruises, strains, and other slight accidents of the same nature, most commonly beginning or taking its origin in the skin of some part, and gradually enlarging by a continual accumulation in the diseased part, until by time it becomes of a very considerable size in some cases.

Enlargements of this nature are seldom painful, and in many instances they are of several years duration before they ever reach any great magnitude; becoming quite indolent and somewhat like the natural flesh, having rarely any other sensible effect than that of causing a deformity and weight in the parts where they happen to be situated. The substance of them is, for the most part, of a sort of fleshy and often spongy nature, though, in some cases, there is a kind of sponginess mixed with a degree of hardness, and occasionally a scirrhous or cancerous disposition accompanies them, especially when they take place in the

neighbourhood of parts which are of the more glandulous kind.

In most real cases of this nature, the wen is contained in a sort of cyst or bag, which arises from the injured vessels of the part, and is formed as it slowly advances; and which incloses the whole substance, augmenting in thickness as well as size as it increases.

In the removal and cure of cases of this sort when they make their appearance on any part of an animal's body, trials should first be made to dissolve and disperse them by proper means, such as camphorated spirituous and mercurial applications: and where this cannot be accomplished, as is often the case, the use of the knife or caustic must be had recourse to for the purpose of taking them off or destroying them. In circumstances where the wens are of the pendulous sort, and hang only by a small neck root, they may frequently be easily and conveniently removed by the use of a ligature of the same kind as is employed in taking up large blood-vessels, applying it so as that it may be capable of being gradually made tighter as there may be occasion, until the substance drops off; the part being afterwards dressed and healed by the common digestive ointment or cerate. Bathing and washing the part frequently with the tincture for wounds is also, in some cases, of great utility. See TUMOUR, and WOUND, in *Animals*.

However, in cases where wens have large broad-bottom root parts which are of a knotty stringy nature, the cure, if practicable, is to be attempted by extirpation, or the use of rather mild caustics, dressing the parts as in the case of wounds. It is sometimes the best and safest practice, however, to meddle as little as possible with wens of this sort.

When enlargements of the wenny kind take place on the legs and heels of animals, as is often the case in the horse, in the more simple kinds of them, the cure may be sometimes effected by the use of applications such as hot vinegar and alum; but in case bloody matter be extravasated, suppuration should be promoted by the use of stimulant ointments and washes, and the parts be opened when proper by means of a lancet in a suitable depending situation, the openings being dressed by the wound ointment and tincture.

In these wenny enlargements, the contents are of different kinds, sometimes watery, and at others of a fleshy or thick pasty nature; which, if care be not taken to digest well out, together with the cyst, will not unfrequently collect and fill again. In some instances, the shortest method would be to extirpate them by means of the knife, which, when well performed, and the skin properly preserved, would leave little deformity. However, some of these sorts of enlargements are best let alone, as those of the watery kind in particular, which will wear away insensibly in many instances, without any application except a little camphorated mercurial ointment.

WENS of Pearl. See PEARL.

WENBACH, in *Geography*, a river of France, which runs into the Rhine, 3 miles above Drusenheim.

WENCESLAUS, or WINCESLAUS, in *Biography*, the son and successor of Charles IV., whom he succeeded as emperor of Germany and king of Bohemia, in his 17th year. In the progress of his life, he became notorious both for cruelty and debauchery, and for the most extravagant profusion, for the means of which he had recourse to the most flagitious conduct.

His extravagance, however, became at length so intolerable, that the Bohemians, in 1396, with the advice of his

his brother Sigismund, king of Bohemia, put him into confinement; from which he contrived to escape, and again to assume the royal authority. But as he pursued the same conduct, his brother Sigismund, at the request of the people, deposed him, and he was declared regent. Wenceslaus, after having been confined successively in various prisons, made his escape from one of the towers of Vienna, and returning to Prague, recovered his kingdom. After a second marriage, his extravagance involved him in new difficulties, so that, in order to his disembarassment, he was under a necessity of selling his imperial rights to John Galeazo, who had seized the sovereignty of Milan, and other cities of Lombardy dependant on the empire. The princes of the empire became indignant, and assembled a diet in 1400, in which they formally deposed him. Professing himself happy at this event, which would afford him leisure to pay attention to the government of his kingdom, he held the crown of Bohemia for 19 years longer, more tolerable in his vices, though still unreclaimed from them. The disturbances of Bohemia, occasioned by the preaching of John Huss, occurred in his time, and he took pains to compose them. At length, whilst he was sitting at dinner, he received intelligence of a sudden tumult at Prague, which occasioned a paroxysm of rage, that was followed by an apoplexy, which terminated his life in 1419, at the age of 58. Mod. Un. Hist. Moreri.

WENDEL, in *Geography*, a town of Sweden, in Upland; 15 miles N. of Upfal.

WENDELEN, a town of Sweden, in Harjeadalen; 18 miles S.E. of Langaschantz.

WENDELL, a township of Massachusetts; 90 miles N.W. of Boston.—Also, a township of New Hampshire, in the county of Cheshire, containing 447 inhabitants; 30 miles N.W. of Concord.

WENDELSTEIN, a town of Germany, in the principality of Anspach; 8 miles S. of Nuremberg. N. lat. 48° 18'. E. long. 11° 4'.—Also, a town and ruined citadel of Thuringia; 6 miles S.W. of Querfurt.

WENDEN, a town of the duchy of Westphalia; 4 miles S. of Olpe.—Also, a town of Prussia, in the province of Bartenland; 6 miles N. of Raftenburg.

WENDIA, in *Botany*, a new umbelliferous genus, thus named by professor Hoffmann, in honour of Dr. Wendt, professor of Physic at Erlang, counsellor to the Elector Palatine, and successor to the great Schreber in the distinguished situation of President of the Imperial Academy *Natura Curiosorum*. He is celebrated for the numerous observations which he has published, respecting medicinal plants, and for his zeal in the promotion of botanical studies in general.—Hoffm. Gen. Plant. Umbellif. v. 1. 136. t. 1. B. f. 8, a, b.—Class and order, *Pentandria Digynia*. Nat. Ord. *Umbellatae*, Linn. *Umbelliferae*, Juss.

Gen. Ch. *Cal. General involucreum* none; *partial* of a few short, unequal, lanceolate or linear, deciduous leaves. *Petiole* of five unequal teeth, two of them, in the radiant flowers, twice as large as the rest, ovate, acute. *Cor. Universal* irregular; flowers of the radius perfect, fertile, except a few males which are interspersed: *partial* of five petals, with long claws; the outer ones in the radius very large, the middle one divided almost half way down into two divaricated, linear-oblong, obtuse, slightly falcate, equal lobes; lateral ones rather smaller, unequally cloven, falcate, one lobe three or four times the length of the other; inner ones much the smallest, about equal to the petals of the disk, two-lobed from their incurvation, their point ovato-lanceolate, acute, channelled. *Stam.* Filaments five, simple, equal, spreading,

the length of the smaller petals longer than the petals in the flowers of the disk; anthers nearly ovate, two-lobed. *Pist.* Germen oval, compressed, striated, hairy; styles two, erect, at length widely spreading, tapering, their base conical, winged with a membranous crisped border running down from each style; stigmas capitate, obtuse, at length somewhat globular. *Peric.* Fruit almost perfectly smooth, obovate, nearly orbicular, compressed, bordered, striated and striped, entire at the edges. *Seeds* two, uniform, emarginate, crowned, in the terminal notch, with the conical, winged, sessile base of the two deflexed permanent styles: dorsal ribs three, slender, slightly elevated, converging at each end; marginal ones two, parallel: stripes four, descending from the top of the seed between the ribs, obtuse, club-shaped, brownish, not half the length of the seed: border convex, terminating in a thin, flat, sharp edge, which is channelled externally, emarginate at the bottom.

Eff. Ch. *General involucreum* none; *partial* obsolete. Flowers radiant. Calyx unequally toothed. Fruit nearly orbicular, compressed, notched, with three ribs, and four short intermediate stripes; crowned with the styles, whose base is winged.

Obf. The want of a general involucreum, and the slightness of the partial one, added to the more orbicular form of the seeds, and their smoothness, appear to afford the chief marks of distinction between this genus and *HERACLEUM*, (see that article,) from which we should be rather unwilling to separate it, any more than *Sphondylium*.

The only species mentioned by the author is,

1. *W. Chorodanum*. Long-leaved *Wendia*. Hoffm. n. 1. (*Heracleum longifolium*; Marfch. à Bieberst. Taur. Caucaf. v. 1. 223, excluding all the synonyms.)—Native of the grassy declivities, surrounding the Caucasian mineral waters of Nartfana, flowering in July. The root is biennial. *Leaflets* two pair with an odd one. General and *partial involucreum* scarcely discernible. *Flowers* snow-white; those of the radius remarkably unequal. *Seeds* when bruised agreeably fragrant. The author of the *Flora Taurico-Caucasica* says, he thinks this more akin to *Heracleum Sphondylium*, with which Crantz and Lamarek unite it, than to the *angustifolium* of Jacquin, to which it is referred by Willdenow. The latter, however, proves to be a different plant, and it is probable that Willdenow had no knowledge of Hoffmann's *Wendia*, any more than Jacquin, Crantz, or Lamarek, all their observations referring to the real *H. longifolium* of Fl. Austrac. t. 174.—The specific name, *χοροδανον*, is an old synonym of the *Sphondylium*, or Cowparsnep.

WENDING, at *Sea*, a term for bringing a ship's head about, and seems only to be a corruption from *winding*. They say, *How wends the ship?*

WENDLANDIA, in *Botany*, owes its name, though not its distinction as a genus to the late professor Willdenow, who dedicated it to the author of that distinction, Mr. John Christopher Wendland, curator of the royal garden at Herrenhausen, "a most acute botanist, and highly meritorious writer." His name appears in the *Sertum Hannoveranum* of the very eminent professor Schrader, as the delineator and engraver of the plates of that work. These display great botanical skill and attention.—Willd. Sp. Pl. v. 2. 275. Pursh 252. ("Androphylax; Wendland Obf. 37.")—Class and order, *Hexandria Hexagynia*. Nat. Ord. *Menisperma*, Juss.

Eff. Ch. *Calyx* of six leaves. Petals six, succulent. Styles reclining. Capules six, of one cell. Seeds solitary.

1. *W. populifolia*. Poplar-leaved *Wendlandia*. Willd.

Pl. 1. Pursh n. 1. (*Menispermum carolinum*; Linn. Sp. Pl. 1468. Willd. Sp. Pl. v. 4. 825. Ait. Hort. Kew. v. 5. 404. *M. folio hederaceo*; Dill. Elth. 223. t. 178. *Androphylax scandens*; "Wendl. Obs. 38. Hort. 3. t. 16." *Cocculus carolinus*; De Cand. Syst. v. 1. 524.)—Found in hedges and woods, from Carolina to Florida, flowering in June and July. *Stem* shrubby. *Flowers* very small, greenish-white. *Berries* red. *Purf.* Hardy in the gardens of Europe, where M. De Candolle says it is very frequent, flowering in August. *Stem* twining, with round branches, striated and downy when young. *Leaves* alternate, heart-shaped, or broadly ovate, entire, tipped with a small point, rarely three-lobed; an inch and a half or two inches long, with three or five radiating ribs; downy beneath. *Footstalks* round, downy, about an inch in length. *Flower-stalks* axillary; those of the male flowers, (which are generally, not always, distinct from the female,) racemose, simple; those of the female three-cleft.

Professor De Candolle has referred this plant to his genus *Cocculus*, separated from *MENISPERMUM*, (see that article,) on account of the flowers being three-cleft, not four-cleft, to use the Linnæan language; and the stamens only six, instead of from sixteen to twenty. We cannot but hesitate to adopt a genus so circumstanced, and therefore shall say little concerning the name, which its antiquity can hardly authorize. We regret to perceive that our learned friend seems inclined to make antiquity paramount to every other consideration in nomenclature; thus assuming a principle subversive of all his own authority, which otherwise might be of sufficient weight to render the most important service to this branch of botany. We hope he will soon perceive, that sense and learning are as applicable to it as to any other part of the science, and full as necessary to preserve the whole from ruin.

If the name of *Cocculus* should be discarded, though the genus be retained, still that of *Wendlandia* can scarcely take its place; there being several others, good or bad, certain or uncertain, which have a prior claim on the score of antiquity. With these we will not here encumber our paper. The reader may find them in De Candolle.

WENDLING, in *Geography*, a town of Austria; 3 miles W. of Tauffkirchen.

WENDLINGEN, a town of Wurtemberg, on the river Lauter, near the Neckar; 12 miles S.E. of Stuttgart. N. lat. 48° 38'. E. long. 9° 27'.

WENDOVER, an ancient borough and market-town in the hundred of Aylesbury, and county of Buckingham, England, is situated in Aylesbury Vale at the distance of 24 miles S.E. by S. from the county-town, and 35 miles N.W. by W. from London. It consists principally of brick houses: the inhabitants derive their chief support from lace-making; but as a branch of the Grand Junction Canal has been recently conveyed to the town, it will probably advance in importance. The earliest charter for a market at this place is dated in 1403. A subsequent charter of the year 1464 confirms the market, and grants two fairs, which are still held. This borough sent members to parliament in the 28th of Edward I., and again in the 1st and 2d of Edward II.; after which the privilege was discontinued for above three hundred years: when in the 21st of James I. Mr. Hakeville, a barrister of Lincoln's-Inn, discovered, by a search among the parliament writs in the tower, that members had been formerly sent. A petition was accordingly preferred for the restoration of the ancient franchise; and though strenuously opposed by the court, the commons decided in favour of the borough. The right of election is vested in all the housekeepers not receiving alms. The

voters are not however more than 130, most of whom occupy the burgage houses rent free. The celebrated John Hampden represented this borough in five parliaments. In the population return of the year 1811, Wendover is stated to contain 283 houses, and 1481 inhabitants. The parish-church stands a quarter of a mile from the town, but contains nothing worthy of particular notice. Near the town is a large reservoir of water, which covers about seventy acres: it was made for the supply of the canal.—*Beauties of England and Wales*, vol. i. Buckinghamshire; by J. Britton, and E. W. Brayley, 1801. *Lynson's Magna Britannia*, vol. i. Buckinghamshire, 1806.

WENFORD, a town of Sweden, in West Bothnia; 25 miles N.W. of Umea.

WENG, a town of the duchy of Stiria; 10 miles N.N.E. of Rottenmann.

WENGIA, a town of Sweden, in West Gothland; 32 miles E.N.E. of Gothenburg.

WENHAM, a township of Massachusetts, in the county of Essex, containing 554 inhabitants; 21 miles E.N.E. of Boston.

WENHOFDORF, a town of Austria; 5 miles N.W. of Schwannstatt.

WENJAN, a town of Sweden, in Dalecarlia; 44 miles W.N.W. of Fahlun.

WENIGZELL, a town of the duchy of Stiria; 11 miles W.S.W. of Fridberg.

WENINGS, a town of Germany, in the county of Isenburg; 4 miles N.W. of Birstein.

WENLOCK, GREAT, or MUCH, a borough and market-town in the hundred of Wenlock, and county of Salop, England, is situated 14 miles S.E. from Shrewsbury, and 147 miles N.W. from London. It is but poorly built, and consists of only two streets, but contains an ancient corporation, and is said to have sent members to parliament, by a writ from Edward IV. in 1478, when it sent one member; but now, jointly with Broseley and Little Wenlock, it returns two. The free burgesses, who are the electors, amount to one hundred and ten. By a charter from Charles I., the corporation consists of a bailiff, recorder, two justices of the peace, and twelve capital burgesses. The whole number of the inhabitants, by the population return of the year 1811, is enumerated as 2079, occupying 494 houses. Four annual fairs are held here; and a weekly market on Mondays. In the reign of Richard II., Wenlock was as famous for copper-mines, as it is now for quarries of limestone. The parish-church bears some marks of Norman architecture. A large round arch separates the nave from the chancel: at the west end is a square tower, with circular headed windows, from which rises a slender spire of wood, covered with lead. The interior is well fitted up: on the right of the altar are some niches; but there is no monument of sufficient antiquity or sculpture to attract the notice of the antiquary. Wenlock owes its celebrity principally to the remains of an ancient abbey, which was subsequently converted to a priory for Clugniac monks. This house was founded about the year 680, by St. Milburga, daughter of Merward, and niece of Wulphere, king of Mercia: she presided as abbess, and died about the year 716. The Danish ravagers are said to have reduced this nunnery to a state of utter desolation, in which it lay until Leofric was appointed to the earldom of Mercia. Soon after the year 1017, that earl, at the instance of his pious consort the lady Godiva, restored it; but with so little success, that, according to Malmesbury, it was found an heap of ruins, by Roger de Montgomerie, the first Norman earl of Shrewsbury, who rebuilt it in 1080, and filled it with monks from Clugni.

It is certain that none of the existing remains are older than his time; and these are confined to the chapter-house; for not a vestige is now to be traced of the pillars of the choir, which are known to have been circular, massive, and Norman. The parish-church was indeed rebuilding at, or just before the time when Malmesbury wrote (about 1127); for it was on the occasion of commencing the building of the new church, that the discovery was made of the body of St. Milburga, whose sacred relics are said to have effected many miraculous cures. The parish-church still retains evident marks of having been erected at a period consistent with this narrative: but no part of the priory, except what has been already mentioned, can lay claim to any such antiquity. The remains of the patron saint appear to have been transferred from the church of the parish to that of the priory, and perhaps some new works erected with the treasures which poured in from their fortunate discovery; for when Gervase Paganel resolved to build a priory at Dudley, which he appears to have done early in the reign of king Stephen, "he placed his deed of gift with his own hand upon the altar of St. Milburga of Wenlock, in presence of all the convent, to whose protection he committed his new foundation." Indeed the priory of St. Milburga was in such high repute for sanctity of life and strictness of discipline during this century, that in 1164 it furnished a colony of monks for the abbey of Paisley in Clydesdale. The number of monks maintained within the priory was forty, and the same appears to have been about the original number of stalls in the chapter-house: though in 1374, when an inquiry was instituted into the state of the alien priories, it was found to contain only seventeen monks. The priory was surrendered January 31. 1539-40, when a pension of 80*l. per annum* was settled upon the prior, John Cressage, and the manor-house of Madeley was assigned for his residence. The revenues of the monastery, according to Dugdale, amounted, at the time of the dissolution, to 401*l. or. 7½d.* The site was granted by Henry VIII. to one Augustino de Augustinis, who sold it, in 1545, to Thomas Lawley, esq., who made it his residence, and in whose descendants it continued, till Robert Bertie, esq., son of his great-granddaughter Urfula Lawley, by sir Robert Bertie, K.B., sold it to the family of Gage. Lord viscount Gage alienated it to sir John Wynn, bart., who devised this with his other great estates, to his kinsman sir Watkin Williams, bart., who thereupon assumed the name of the testator: he was grandfather of sir Watkin Williams Wynn, bart., the present proprietor of these venerable ruins.

Few of our English monastic remains, perhaps, are capable of affording more instruction and amusement to the lovers of ecclesiastical architecture, than those of Wenlock. The ruins are seated in a low marshy bottom, southward of the ancient borough, and adjoining the east end of the parish church-yard. The chief entrance to the monastery, from the town, was by a gate on the north side of the precinct, which appears to have been flanked with two plain square towers, one of which is standing. The most prominent features of the present buildings, are the lofty and extensive remains of the priory church, which have happily escaped the ravages of time. From these it is apparent that this sacred edifice partook of the mixed characters of the round and the pointed arch. Its magnificence fully corresponded with the opulence of the foundation, and was not surpassed by many of the stately churches of the mitred abbeys. The plan of the church was cruciform, with a central tower, but probably without towers at the west end. The extreme length was 401 feet; that of the transept 166; the nave 156; the space under the steeple 39; the choir 156;

and the chapel of the Virgin Mary 48. A fragment of the south angle of the west front is ornamented with three tiers of small arches: a window below is finished with a plain round arch. The great west window is now no more, but from the remains of one of its impostes, which is a taper-clustered pilaster, bound midway with rings, its form may be conjectured to have consisted of three lofty lancet arches. Three pointed arches on the south side of the nave are perfect, and rest on strong octagonal pillars with plain capitals. Over these commences a second division, separated by an horizontal string-course; this comprises a beautiful triforium, or open gallery, formed by lancet arches in couplets. Above these is a third compartment, from which rises a series of pointed clerestory windows, now mutilated, but evidently in the same style with the arches of the gallery beneath. A considerable fragment of the north, and the whole of the south wing of the transept are standing, both in a style coeval with the nave. The latter, a very beautiful ruin, is composed of three pointed arches on each side, resting on clustered columns, with plain but well-executed capitals. The bases of the four grand piers, which supported the steeple over the intersection of the nave, transept, and choir, may be traced nearly buried in rubbish; and evident vestiges of clustered shafts indicate that they sustained pointed arches. Of the choir, scarcely a wreck remains, yet within these few years, the lower members of six pillars, of plain and massy Norman architecture, might be discerned. Further eastward appears the foundation of the Virgin Mary's chapel, consisting of excellent masonry, with several deep basement mouldings. On the eastern side of the quadrangle was the chapter-house, a parallelogram of sixty feet by thirty, of which a very large portion is standing; and a more rare display of Norman architecture of the eleventh century can hardly be produced. The north side is almost entire. A few paces south-eastward of the chapter-house are the remains of a second quadrangle, the buildings of which, on two sides, are nearly entire. Those on the eastern side, it is presumed, belonged to the lodge of the prior, and, at the dissolution, were preserved for a mansion-house by the first lay possessors of the monastery. This consists of a long range of two stories, not very lofty, with a highly pitched and tiled roof. Along the whole front runs an elegant cloister, 100 feet in extent, composed of a series of narrow arches in couplets, with trefoil heads, and strengthened at frequent intervals with slender shelving buttresses. The eastern front of the house is adorned with ranges of rather singular windows, which have acute triangular heads, and are arranged in couplets united by very slender buttresses.—*Beauties of England and Wales*, vol. xiii. Shropshire; by R. Rylance, 1811. *Architectural Antiquities of Great Britain*, vol. iv.; by J. Britton, F.S.A. 1814.

WENLOCK, or *Winlock*, a town of Vermont; 90 miles N. of Windsor.

WENLOCK, *Little*, a town of England, in Shropshire; 8 miles N. of Much Wenlock.

WENMAN, one of the Gallipago islands, in the Pacific Ocean.

WENNE, a river of Westphalia, which runs into the Roer, 3 miles below Eversberg.

WENNEL, a river of North Wales, which runs into the Conway, near Llanrwst.

WENNER LAKE, the largest lake of Sweden, in West Gothland; nearly 90 miles long, and 40 wide. This lake is stored with great plenty of fish. Twenty-four rivers empty themselves into the Wenner lake, yet none flows out of it but the large river called Gotha Elbe, by which out-

let it discharge itself into the sea. There are several islands in this lake. In the year 1744, the diet resolved to make the passage from the Wenner lake and the Gotha Elbe to Gotheborg, and from thence to Orebro, navigable. See *CANAL of Trolhatta*.

WENERSBORG, a town of Sweden, in West Gothland, at the south-west extremity of Wenner lake. This town was once a fortress, but at present an open town. It is the staple for all the iron sent from the province of Warmeland to Gotheborg; 15 miles E. of Uddevalla. N. lat. 58° 26'. E. long. 12° 9'.

WENOOA-ETTE. See OTAKOOTAI.

WENSBECK, a river of England, which rises in Northumberland, passes by Morpeth, and runs into the German sea, N. lat. 55° 13'.

WENSYSSEL, a town of North Jutland, anciently the see of a bishop, removed to Aalborg; 18 miles N.W. of Aalborg.

WENT, a river of England, in the county of York, which runs into the Don.

WENTHUSEN, a town of Westphalia, in the bishopric of Hildesheim; 5 miles E. of Hildesheim.

WENTSCHEN, a river of Prussia, which forms a communication between lake Spirding and lake Wentfchen.—Also, a lake of Prussia; 20 miles S.E. of Bartenstein.

WENTSUM, a river of Norfolk, which runs into the Yare, below Norwich.

WENTWORTH, THOMAS, in *Biography*, Earl of Strafford, was born at London in 1593, and having finished his education at St. John's college, Cambridge, travelled abroad, and continued more than a year in France. Soon after his return he was knighted, and married the eldest daughter of Francis Clifford, earl of Cumberland. By the death of his father in 1614, he became possessed of a patrimony of 6000*l.* a year, which was considerably incumbered by a provision for seven brothers and four sisters, with the title of a baronet. Upon his entrance into public life he was nominated Custos Rotulorum of the West Riding of Yorkshire. In 1621 he was returned as a member of parliament for the county of York, and during two sessions conducted himself with circumspection and moderation. In opposition to the king's assumption of unwarrantable authority, and of his assertion that the privileges of the commons were enjoyed merely by his permission, Wentworth urged the house explicitly to declare that these privileges were their right by inheritance. In 1622 he lost his wife, and in 1625 contracted a second marriage with a daughter of Holles, earl of Clare, a young lady distinguished for beauty and accomplishments; and in this year he was returned for his county to the first parliament of Charles I. At this time he was a zealous opposer of the arbitrary measures that marked the commencement of this unfortunate reign; but as he was deemed a person of considerable importance and influence, the minister thought proper to make efforts for conciliating his attachment and support. As he was prevented from obtaining a seat in the new parliament which was convoked, by being nominated sheriff in his county, he silently submitted to this arbitrary act, and took no part in the contention that subsisted between the court and the house of commons. Buckingham, the tenure of whose power was becoming precarious, made overtures to Wentworth, and though they parted upon the best terms after a conference, he received a mandate for resigning the office of Custos Rotulorum to sir John Savile, whom he had succeeded on his dismissal. This conduct on the part of the favourite was attended with some aggravating circumstances, and very much incensed him; but he still expressed sentiments of un-

changed loyalty. Nevertheless he refused to pay his contribution to the forced loan imposed without the intervention of parliament, and for his opposition to the measure he was first imprisoned in the Marshalsea, and afterwards confined to a range of two miles round the town of Dartford. When a new parliament was summoned, in 1628, this restriction terminated, and he took his seat for Yorkshire. In this season of competition between the advocates of an arbitrary and those of a limited monarchy, Wentworth took a decided and conspicuous part with persons of the latter description, and was one of the most active promoters of the famous Petition of Right. By the measures which he then adopted and pursued, he shewed that he was worthy the purchase of the crown, nor had he virtue sufficient to withstand the temptations by which he was assailed. These were a peerage, and future promotion to the office of president of the council of York, or court of the north. He agreed to the proposed terms; and in July 1628 was created baron Wentworth, Newmarsh, and Oversey, by a patent gratifying his vanity by recognizing his claim to an alliance with the blood-royal, through Margaret, grandmother of Henry VII. Soon after he was advanced to the dignity of a viscount, admitted to the privy-council, and on the resignation of lord Scrope nominated lord-president of the north, with enlarged jurisdiction and powers, the exercise of which afterwards exceeded or directly violated the common law, and overwhelmed the country with oppression and arbitrary dominion. From this time Wentworth may be regarded as a minister and statesman, whose influence at court was in a little while freed from controul by the assassination of Buckingham, and in a popular assembly by the dissolution of parliament. Devoted to the faithful and diligent service of the crown, he obtained the confidence and support of government; and thus elevated, he manifested a haughtiness and imperiousness of temper which augmented the unpopularity resulting from a desertion of his former principles and party. Having cultivated an intimate friendship with archbishop Laud, who had succeeded Buckingham in his influence over the king's mind, he was recommended by this prelate for the direction of affairs in Ireland; the peculiar circumstances of which were thought to require the vigour and decision of Wentworth's character. Accordingly his commission as lord-deputy of Ireland was dated in 1632, though he did not remove to that country till July in the following year. The objects which he proposed in the administration of that kingdom were to render the royal authority uncontrollable, to improve the revenues, so as to render them adequate to its own expenditure, and to afford a surplus for the English treasury, and upon the whole, to derive from it every possible advantage to the monarchy. He stipulated also for the uncontrolled exercise of his own authority. Of the various measures which he pursued in his government of Ireland, our limits will not allow us to give a minute and correct detail; but for an account of these we must refer to the history of that period. His talents and industry were unquestionable, and he certainly improved the state of the country in a variety of respects; but in accomplishing some beneficial purposes he was arbitrary and tyrannical, and chargeable with severe and vindictive proceedings, which made him unpopular both there and in England; and which probably induced the king to mortify him by refusing his request of an earldom. In 1636 he visited the English court, and made a speech before the king and the committee for Irish affairs, in which he gave a minute detail of his various measures by which he had promoted the good of that kingdom and the interest of his majesty, artfully apologizing at the same time for the infirmities of

his temper. As a farther evidence of his merits with the court, he took notice of his zeal in supporting the imposition of ship-money in the exercise of his office as president of the council of York; and thus he prepared the way for renewing his petition for an earldom, which, notwithstanding his earnestness to obtain it, was again refused. Thus mortified, he refused his government with ample powers, and pursued measures similar to those which had given so great offence. His indefatigable application to business, and the irritation occasioned by the complaints and clamours of those who had reason to be dissatisfied with his conduct, subjected him to some severe paroxysms of the gout. In 1637 he advised the king not to engage in a war with Spain, and he thus incurred the lasting enmity of the queen, who wished for it, as favourable to the interest of France. In the court contest between England and Scotland, Wentworth was both an adviser and actor. After the failure of the king's first expedition against Scotland, he sent for the lord-deputy of Ireland, who arrived in November 1639. He advised the immediate renewal of hostilities, and the summoning of a parliament to provide supplies; and in order to secure his continued attachment and assistance, he obtained the earldom which he had once and again fought in vain. In January 1640 he was created earl of Strafford, decorated with the garter, and his style of lord-deputy of Ireland was changed into that of lord-lieutenant, which had been dormant from the time of the earl of Essex. Upon his return to Ireland he obtained four subsidies, and levied 8000 men for reinforcing the royal army. Afterwards the office of commander-in-chief devolved upon him; but though the Scots prevailed, and the northern counties were surrendered to the enemy, Strafford still recommended strong and arbitrary measures. His credit at court, however, was now declining, and the king was obliged by his necessities to call a parliament, which proved eventually to be the "long parliament." Strafford, perceiving his own perilous situation, requested leave to retire to his government; but the king refused to comply, and encouraged him by a solemn promise that "not a hair of his head should be touched by the parliament." The sequel shewed that Strafford's apprehensions were well-founded; for on November the 18th, 1640, Pym, in the name of the commons of England, appeared with the charge of high treason at the bar of the house of lords; and Strafford was sequestered from parliament and imprisoned. The fallen minister was now become the object of accusation in the three kingdoms; but the desertion and hatred of Ireland most deeply affected him. The articles of accusation against him were at first nine, but in the course of three months they were multiplied into twenty-eight. The principal object of his accuser was to fix upon him the charge of "having attempted to subvert the fundamental laws of the country." Against this charge he defended himself with wonderful self-possession and powers of reasoning. It became necessary, therefore, to change the original impeachment into the arbitrary mode of proceeding by a bill of attainder, in pursuing which process it was only necessary to pass an enactment of his having been guilty of high treason, and having incurred its punishment. The bill passed the house with no more than fifty-nine dissentient voices; but among these were those of some of the firmest friends of the legal liberty of their country, who thought the principles of justice shamefully violated; and in the house of lords the bill was carried more by intimidation than conviction. Hopes were still entertained from the king's promise, and his attachment to a faithful servant. But firmness was not one of the king's distinguishing virtues. His interference to stop the progress of the bill in the house

of lords had failed; and he even recurred to the plea of conscientious scruples. But his counsellors urged the danger of resisting the torrent of popular fury; the prelates, Juxon excepted, acted the part of casuists; and Strafford himself terminated the struggle by a letter, in which he persuaded the king for his own safety to ratify the bill, thus concluding it, "my consent shall more acquit you to God than all the world can do besides. To a willing man there is no injury." Love of life, however, seems to have induced him to have placed confidence in the king's promises: for when secretary Carleton informed him of his majesty's final compliance with his solicitations, he lifted up his eyes to heaven, and with his hand on his heart, exclaimed, "Put not your trust in princes, nor in the sons of men: for in them there is no salvation!" Strafford, between his condemnation and execution, employed himself in administering consolation and advice to his distressed family, and making interest for their protection. On the final day, as he was quitting the tower, he looked up to the windows of Laud's apartment, and obtaining a view of him, received his fervent blessing, which he returned with "farewell my lord! God protect your innocence!" At the scaffold he made an address to the people, expressing entire resignation to his fate, and asserting the good intention of his actions, however they might have been misrepresented; and then, taking leave of his accompanying friends, with a pathetic recollection of his widowed wife and orphan children, he calmly laid his head on the block, and giving a signal, received the single stroke that deprived him of life. He fell in the forty-ninth year of his age, lamented by some, admired perhaps by more, and leaving a memorable, though not a spotless name. The parliament, not long after his death, mitigated the sentence as far as it affected his children; and in the succeeding reign his attainder was reversed, and his heir was restored to his estate and honours." Lord Strafford was thrice married, and left an only son and several daughters. Biog. Brit. Whitelock's Mem. The Histories of the Period.

WENTWORTH, in *Geography*, a township of England, in the West Riding of Yorkshire, with about 1000 inhabitants; near it is Wentworth-House, a seat of earl Fitzwilliam; 5 miles N.W. of Rotherham.—Also, a township of New Hampshire, in the county of Grafton, containing 645 inhabitants; 3 miles S.E. of Oxford.

WENTZBURG, a town of the duchy of Warfaw; 40 miles E. of Gnesna.

WEOBLEY, an ancient borough and market-town in the hundred of Stretford, and county of Hereford, England, is situated 11 miles N.W. by N. from the city of Hereford, and 141 miles N.W. by W. from London. Anciently it formed part of the barony of the Lacies, from whom, by a female, it was conveyed in marriage to the Verdons, who, by that alliance, were for some time hereditary constables of Ireland. It afterwards passed through various families to the Devereux, earls of Essex, and formed their principal lordship. On the south side of the town stood an old castle, which was taken from the empress Maud by king Stephen. Leland mentions it as "a goodly and fine building, but somewhat in decay." Weobly sent members to all the seven parliaments of Edward I.; the privilege was afterwards discontinued till the year 1640, when it was restored by order of the house of commons. The right of voting is possessed by the owners of the ancient burghage houses, resident at the time of election, or by the inhabitants of such houses who have been resident forty days. The number of voters is about forty-five: the returning officers are the constables, in whom the government of the town is vested. The church is spacious, and

and contains some ancient monumental chapels, in which some of the Verdon family appear to have been interred. The population of the parish, as returned under the act of 1811, amounted to 626; the number of houses to 160. A small weekly market is held on Thursdays; and here are two annual fairs.—*Beauties of England and Wales*, vol. vi. Herefordshire, by J. Britton and E. W. Brayley, 1805.

WEPFER, JOHN-JAMES, in *Biography*, an eminent physician, was born in 1620 at Schaffhausen, educated at Strasburg and Basle, and after visits to several universities in Italy, took the degree of doctor at Basle, and settled in his native place. His reputation was extensive in Switzerland and Germany, and he attained, by his dissections and experiments, a high rank among those who have contributed to improve medical science. In 1658 he published a celebrated work, entitled "*Observationes Anatomicæ ex Cadaveribus eorum quos sustulit Apoplexia, cum Exercitatione de ejus loco affecto*," 8vo., often reprinted, and in some editions with the title "*Historia Apoplecticarum*." In his "*De dubiis Anatomicis Epistola*," 1664, 8vo., he asserts the entire glandular structure of the liver, prior to Malpighi. Another valuable work is entitled "*Cicutæ Aquaticæ Historia et Noxæ*," 1679, 4to.

His constitution was injured by attendance at an advanced age on the duke of Wurtemberg, and the Imperial army under his command; and he was carried off by a dropsy in 1695. His papers were published by two of his grandsons, in a work entitled "*Observationes Medico-Practicæ de affectibus Capitis internis et externis*," 1727, 4to. To the *Ephemerides Naturæ Curiosorum*, of which society he was a member, he communicated several valuable papers. Haller. Eloy.

WEPOLON, in *Zoology*, the Ceylonese name of an East Indian serpent, of a very long and slender body, and in some degree resembling a piece of cane.

WERAY, in *Geography*, a river of Wales, which runs into the Irish sea, 7 miles S. of Aberystwith.

WERBEN, a town of Brandenburg, in the Old Mark, at the conflux of the Havel and the Elbe. This town was built by Henry the Fowler, on the ruins of the ancient Castellum Vari; 33 miles N.N.W. of Brandenburg. N. lat. 52° 53'. E. long. 29° 44'.—Also, a town of Pomerania; 9 miles S.S.W. of Stargard.

WERBERG, a town of Westphalia, in the bishopric of Fulda; 12 miles S.S.E. of Fulda.

WERBKA, a town of Russian Poland, in the palatinate of Braclaw; 36 miles S. of Braclaw.

• WERD, a town of Carinthia, on a lake to which it gives name; 8 miles W. of Clagenfurt.

WERDA, a town of Saxony, in the Vogtland; 6 miles N.E. of Oelnitz.

WERDAU, a town of Saxony, in the circle of Erzgebirg; 6 miles W. of Zwickau.

WERDEL, ST., a town of France, in the department of the Sarre; 40 miles S.E. of Treves. N. lat. 49° 30'. E. long. 7° 11'.

WERDEN, a town of Germany, in the county of Mark, on the Roer; 11 miles N.E. of Dusseldorp. N. lat. 51° 18'. E. long. 6° 55'.

WERDENA, a town of Prussian Lithuania; 18 miles N.N.W. of Tilsit.

WERDENBERG, a town of Switzerland, and capital of a bailiwick, in the canton of Glarus, which was formerly governed by counts of its own, who were at one time very powerful. In the year 1485, it was purchased by the can-

ton of Lucerne; and, after changing owners, in the years 1493 and 1498, was purchased by the canton of Glarus, in the year 1519, and has remained ever since annexed to that canton, though the inhabitants have several times been mutinous and revolted. The town is fortified; 11 miles S.S.E. of Appenzell.

WERDENFELS, a town and castle of Bavaria, which gives name to a county in the bishopric of Freyung; 20 miles S. of Weilhaim.

WERDER, a town of Brandenburg, in the Middle Mark, on an island formed by the Havel; 4 miles W. of Potsdam.—Also, a district of Pomerania, between the two branches of the Vistula, about 20 miles long, and 12 in its mean breadth.

WERDING, a town of Austria; 4 miles N.N.W. of Schwannstadt.

WERDT, or WERT. See WEERT.

WERE, or WEAR, a river of England, which rises in Northumberland, crosses the county of Durham, and runs into the sea at Sunderland; anciently called "Vedra."

WERE, a river of England, which rises near Warmminster, in Wiltshire, and runs into the Avon, near Trowbridge.

WERE. See WEIR.

WERE, *Wera*, in our old *Law-Books*, signifies as much as *estimatio capitis*, or *pretium hominis*; that is, so much as was anciently paid for killing a man.

When such crimes were punished with pecuniary mulct, not death, the price was set on every man's head, according to his condition and quality. *Were suum*, id est, *pretium sue redemptionis*, his ransom.

WERELADA, among our Saxon ancestors, the denying of a homicide on oath, in order to be quit of the fine, or forfeiture, called *were*.

Where a man was slain, the price at which he was valued was to be paid to the king, and his relations: for, in the time of the Saxons, the killing of a man was not punished by death, but by a pecuniary mulct, called *wera*.

If the party denied the fact, he was to purge himself, by the oaths of several persons, according to his degree and quality. If the guilt amounted to four pounds, he was to have eighteen jurors on his father's side, and four on his mother's: if to twenty-four pounds, he was to have sixty jurors; and this was called *werelada*. *Homicidium wera solvatur, aut werelada negetur*.

WEREGILD, WEREGELD, in our *Ancient Customs*, the price of a man's head: *pretium seu valor hominis occisi, homicidii pretium*; which was paid partly to the king for the loss of his subject, partly to the lord whose vassal he was, and partly to the next of kin.

This was a custom derived to us, in common with other northern nations, from our ancestors, the ancient Germans; among whom, according to Tacitus (*De Mor. Germ. cap. 21.*), *luitur homicidium certo armentorum ac pecorum numero; recipitque satisfactionem universa domus*.

In the same manner, by the Irish brehon law, in case of murder, the brehon, or judge, compounded between the murderer and the friends of the deceased, who profecuted him, by causing the malefactor to give unto them, or to the child or wife of him that was slain, a recompence, which they called *eriach*. And thus we find in our Saxon laws, particularly those of king Athelstan, the several weregilds for homicide, established in progressive order, from the death of the ceorl, or peasant, up to that of the king himself. And in the laws of king Henry I. we have an account what other offences were then redeemable by weregild, and what were not so. The process called *appeal* had probably

its rise in the times when weregild was in use. Blackitt. Comm. vol. iv.

The weregild of an archbishop, and of an earl, was 15,000 thrimas; that of a bishop, or alderman, 8000; that of a general, or governor, 4000; that of a priest, or thane, 2000; that of a king, 30,000: half was to be paid to his kindred, and the other half to the public. The weregild of a ceorl was 266 thrimas.

WEREMOUTH, BISHOP'S, in *Geography*, a parish of England, in the county of Durham, on the river Were, with 7060 inhabitants; 12 miles N.N.E. of Durham. This parish is now incorporated in the town of Sunderland. See SUNDERLAND.

WEREMOUTH, *Monk's*, a parish of England, in the county of Durham, at the mouth of the river Were, opposite Sunderland, with 5355 inhabitants.

WEREN, a river of Wurzburg, which runs into the Maine, 6 miles below Carolstadt.

WERFEN, a town and fortress of the archbishopric of Salzburg, on the Salza, with a castle, memorable for having been the retreat of the archbishop of Salzburg, whom the duke of Bavaria had driven from his capital for having married; 15 miles N.W. of Radstadt.

WERGELA, or GUERGELA, a town of Africa, in Biledulgerid; 300 miles S. of Algiers. N. lat. $31^{\circ} 45'$. E. long. $4^{\circ} 10'$.

WERINAMA, a town on the south coast of the island of Ceram. S. lat. $3^{\circ} 15'$. E. long. $130^{\circ} 18'$.

WERING, or WORINGEN, a town of France, in the department of the Roer; 2 miles S. of Zons.

WERK. See WARK.

WERL, a town of the duchy of Westphalia; 13 miles W.S.W. of Lippstadt. N. lat. $51^{\circ} 33'$. E. long. $7^{\circ} 58'$.

WERM, or WORM, a river of France, which runs into the Roer, near Waffenberg.

WERMSDORF, a town of Saxony, in the circle of Leipzig; 36 miles N.W. of Dresden.—Also, a town of Bavaria, in the principality of Aichstatt; 4 miles N. of Aichstatt.

WERNBERG, a town of Bavaria; 3 miles N. of Pfreimbt.

WERNBURG, a town of Saxony, in the circle of Neustadt; 3 miles N.E. of Rahnis.

WERNE, a town of Germany, in the bishopric of Munster; 19 miles S. of Munster. N. lat. $51^{\circ} 38'$. E. long. $7^{\circ} 48'$.

WERNECK, a town of the duchy of Wurzburg, on the Weren; 5 miles S.W. of Schweinfurt.

WERNER, ABRAHAM GOTTLÖB, in *Biography*, a celebrated mineralogist, and professor of mineralogy at Freyburg, in Saxony, was born on the 25th of September 1750. His father was inspector of an iron-work in Upper Lusatia, and at an early period intended to educate his son for the same employment. The first scanty rudiments of his education were received at a school at Bunseur. He was afterwards sent to the Mineralogical Academy at Freyburg, and from thence to the university of Leipzig, where he applied himself to the study of natural history and jurisprudence; but the former he found more attractive, and it was here that he employed himself in defining the external characters of minerals, for which he was endowed by nature with a singular quickness of perception. At this place, he published, in 1774, his work on the external characters of minerals, which was considered as the basis of his oryctognostic or mineralogical system. (See SYSTEMS of Mineralogy.) It has been translated into various languages, but Werner

could never be persuaded to publish a new and enlarged edition. "In this work," says professor Jameson, "he gave the first example of the true method of describing mineral species. In these descriptions, all the characters presented by the *species suite* are detailed with a certain degree of minuteness, and in a determinate order; so that we have a complete picture of it, and are furnished with characters that distinguish it from all known species, and from every mineral that may hereafter be discovered." It cannot be denied, that previous to this time, the descriptive language of mineralogists had been much too indefinite to convey accurate information, or to enable mineralogists in distant countries to understand each other. Soon after this publication, Werner was invited to have the care of the cabinet of natural history at Freyburg, and to read lectures on mineralogy.

This situation, so well suited to the peculiar studies in which he was engaged, offered abundant materials for the exercise of his talent for observation and classification. In 1780 he published the first part of a translation of Cronstedt's Mineralogy. In his annotations on this work, he gave the first sketch of his mineralogical system, and published many descriptions in conformity with the methods proposed in his treatise on external characters. In this system, we find earthy minerals divided into four genera, siliceous, argillaceous, talcaceous, and calcareous; and these subdivided into species, sub-species, and kinds.

In 1791 he published a catalogue of the great mineral collection of Pabst Von Obaine, captain-general of the Saxon mines. In this work, he gave a tabular view of the whole mineralogical system, in which the arrangement of genus, species, sub-species, and kinds, is continued; several additions are made to the external characters, and the arrangement of the species is in some instances changed, owing to more extended observations. Werner, besides his lectures on mineralogy, also delivered lectures on the art of mining, which he is said to have rendered extremely intelligible by his simplification of the machinery, and by drawings and figures. His system of geognosy, or geology, was delivered in his lectures, but never published by himself. (For some account of this system, see GEOLOGY, and SYSTEMS of Geology.) "In lecturing," says a writer in the Literary Gazette of Leipzig, "he used to abandon himself (as he was accustomed to say) to his mineralogical name, and when his spirit hovered over the waters and the strata, he often became animated with lofty enthusiasm." He caused his lectures to be written out by his approved scholars, and by revising them himself made them his own in manuscript. Many parts of these lectures have been published in different countries by his pupils. Werner also published some mineralogical papers in the Miner's Journal; and in 1791 appeared his new theory of the formation of metallic veins. This work was translated into French by Daubuisson, and into English in 1809.

Werner was appointed counsellor of the mines in Saxony in 1792, and had a great share in the direction of the Mineralogical Academy, and in the administration for public works.

The cabinet of minerals collected by Werner was unrivalled for its completeness and arrangement, consisting of 100,000 specimens. This he sold for 40,000 crowns, reserving the interest of 33,000 as an annuity to himself and his sister, who had no children; and at her death, to be paid annually to the Mineralogical Academy of Freyburg.

This illustrious mineralogist died August 1817, greatly regretted by all those who were personally acquainted with him, to whom he was endeared by the simplicity of his manners,

manners, the cheerfulness and benevolence of his disposition, his integrity and disinterested devotion to science. Werner was never married. His favourite pursuit next to mineralogy appears to have been the study of antiquities, one branch of it, the numismatology of the ancients, had, during the last eight years of his life, engaged much of his attention; and he had formed a collection of 6000 Greek and Roman coins, which enabled him to make researches into the different mixtures of the metals and the arts of adulteration; and to make the subject more clear, he arranged entire series of false coins. He was also attached to the study of medicine, and had made a humorous table of diseases from infancy to old age; and among his peculiarities may be mentioned his desire of offering medical advice to his friends, and his habit of judging of his own situation, which he often thought precarious. He was greatly averse to the use of vinegar and milk, but a determined beef-eater: in other respects he lived temperately, drank but little wine, and was anxiously careful about warm-clothing and rooms, a caution not well suited to the habits of a geologist. Werner had travelled little from his own country; his visit to Paris appears to have been the only distant excursion he ever made from Saxony.

Werner may justly be said to have contributed more to extend and improve the practical knowledge of mineralogy, than any one who had preceded him. His method of observing and describing the external appearances of minerals, has been introduced by his pupils, with some modifications, into various parts of the world, and has given a new and more definite form to the science. It has indeed been objected to the method of Werner, that confining principally in the classification of minerals according to their external characters; and in the description and arrangement of these characters, it may be regarded rather as an empiric art, than a science. But in the mineral kingdom those definite characters are wanting, which serve to distinguish the genera and species in the other departments of natural history; and he who can but relieve this difficulty, and enable the student most easily to gain a knowledge of minerals under all these varying forms, is entitled to the highest praise. This palm may be pre-eminently given to Werner; and whoever has justly appreciated his labours will never stop to inquire, whether his method should rank among the sciences or the arts. Mr. Kirwan was the first who introduced a knowledge of the Wernerian mineralogy into this country; but for a more complete knowledge of it, we are indebted to professor Jameson, in his *System of Mineralogy*, first published in 1804, and in the second edition of 1817.

As a geologist, we cannot allow to Werner the same degree of unmixed praise. His system of geognosie was formed on observations made on a very limited portion of the earth's surface in his own vicinity; and he has laid down a succession of rock-formations as universally spread over the globe, because these rocks occurred in this order in a particular part of Saxony. Subsequent observations have, however, demonstrated, that even at a little distance from Freyburg, many of the supposed universal rock-formations are not to be found, and that other rocks supply their place. The reader may consult a description of the Saxon Erzgebirge by M. Bonnard, in the *Journal des Mines* for 1815, to convince himself of this. It is, we consider, fortunate for Mr. Werner's fame as a geologist, that no work of his on the subject has appeared, except the "*New Theory of Veins*." This for some time enjoyed a certain degree of celebrity from the name of the author; but the new information which it contains is very scanty, and the theory which it supports so inadequate to explain the phenomena,

and so much at variance with facts, that it was in a great part abandoned by many of the warm admirers of Werner, even some years before his death. It will now scarcely meet with a supporter among those who have any practical knowledge of mineral-veins. Mr. Werner contended for the aqueous formation of almost every kind of rock, even pumice-stone and obsidian he maintained were the products of water; and when he was repeatedly invited to visit the volcanic districts of Italy, and the ancient volcanoes of France, he declined an examination which might have greatly endangered his own theory. The followers of Werner as a geologist rest his fame not on his local observations, but on his attempt to generalize his observations, in order to form a theory which should explain the structure of the earth and the mode of its formation. Indeed such was their admiration, that they would not admit his system to be a theory, but considered it as an exposition of demonstrated facts. "This great geognost," says Mr. Jameson, "after many years of the most arduous investigations, conducted with an accuracy and acuteness of which we have few examples, discovered the manner in which the crust of the earth is constructed. Having made this great discovery he, after deep reflection, and in conformity with the strict rules of induction, drew most interesting conclusions as to the manner in which the solid mass of the earth may have been formed. It is a splendid specimen of investigation, the most perfect in its kind ever presented to the world. (Jameson's *Mineralogy*, first edition, vol. i. p. 22.) We believe there are few persons who will not now admit that the admiration and praise here bestowed were disproportioned to the object, whether we regard the merit of Mr. Werner's observations for accuracy as a geologist, or the conformity of his theory with existing appearances.

The method of investigation pursued by Werner in attempting to trace the rocks in a district in succession, from the lowest or fundamental rock to the uppermost stratum, and marking the limits of each rock where it terminates on the surface, was considered by his followers as entirely his own, and was called by them the *method of the Wernerian geognosie*. But this method had been known and practised in England long before we were acquainted with the name of Werner; indeed it is the only one which preceding geologists could practically adopt in surveying a country. On a smaller scale, it had been practised by all intelligent coal-viewers; and it had been exhibited on a larger scale by Mr. Whitehurst, in the descriptions and plates which he has given in his "*Theory of the Earth*." Sauffure followed no system; yet wherever the order of succession was apparent, he has not failed to inform us. But the country which he investigated, (Switzerland,) presents enormous masses, frequently in much apparent confusion, the order of succession being hid by debris or by glaciers. In other instances, whole mountains composed of different rocks appear to have been formed contemporaneously. Sauffure, who had no theory of any regular order of succession to support, has simply described facts as they exist. Our own countryman, William Smith, had been long employed in tracing the limits and order of succession of the strata in the midland and eastern counties of England, before the Wernerian geognosie was known either in England or Scotland.

The originality of the Wernerian geognosie consisted more in the invention of a new language adapted to support a theory, than in the discovery of a new and practical method of investigation. The language is highly objectionable in many respects, as the terms are founded on the premature assumption of the relative ages and modes of formation

of different rocks; — facts which are far from being yet clearly ascertained.

Whatever may be the defects of the Wernerian system as given us by his scholars, and however premature many of the generalizations may have been, it was of use by directing the attention of observers in various parts to an examination of its accordance with facts. Though the different rocks which Mr. Werner has described as universal formations neither occur invariably in the order of succession which he has described, nor are universally spread over the earth's surface; yet there is a certain similarity between the geological arrangement of distant countries when viewed on a large scale, which indicates that similar processes of formation had taken place, and nearly in the same order in remote parts of the globe; but we are far from knowing whether these processes were universal and simultaneous, or local and successive.

In the above observations, which it is our impartial duty as biographers to state, we have not the remotest wish to undervalue the real merits of this eminent mineralogist. His theoretical errors arose naturally from the infant state of geology when he commenced his labours; and his over-weening attachment to opinions too hastily formed, was an infirmity which he shared in common with many eminent philosophers. His errors will pass away with time, but his more useful labours will remain a durable monument of his talents and persevering research.

WERNERITE, in *Mineralogy*, a mineral regarded by Werner as a subspecies of scapolite, but which has been classed by other mineralogists as a distinct species, to which they have given this name, in honour of the professor at Freyburg. The name has been applied to foliated scapolite, compact scapolite, and to a mineral which is called Bergmannite by Stevens and Jameson. (See **SCAPOLITE**.) Wernerite occurs massive and crystallized in octohedral prisms, with four-sided pyramidal terminations. The structure is imperfectly lamellar, with joints on two directions, at right angles to each other. The colour is greenish-grey, with a pearly or resinous lustre, more or less shining; it is translucent. Wernerite is softer than felspar, yielding to the knife; its specific gravity is 3.6. It melts with intumescence into a white enamel.

This mineral is rare: it has been found at Arendal, in Norway; in the mines of Northbo and Ulrica, in Sweden; and at Campo-Longo, in Switzerland. The constituent parts are,

Silex	-	-	-	-	40
Alumine	-	-	-	-	34
Lime	-	-	-	-	16
Oxyd of iron	-	-	-	-	8
Oxyd of manganese	-	-	-	-	1.5

WERNERSDORF, in *Geography*, a town of Pomerania, on the Nogat; 7 miles S.W. of Marienburg.

WERNEUCHEN, a town of Brandenburg, in the Middle Mark; 6 miles E.S.E. of Bernau.

WERNFELS, a town of Bavaria, in the bishopric of Aichstadt; 4 miles N.W. of Spalt.

WERNHAUSEN, a town of the county of Henneberg; 4 miles N. of Wafungen.

WERNIGERODE, a county of Upper Saxony, bounded on the north by the principality of Halberstadt, on the east and south by the principality of Blankenburg, and on the west by the Harz forest; about twelve miles in length, and eight in breadth. One part is mountainous, and the other level. Amongst the mountains, the most distinguished of all is the Great Brocken, or Blockberg,

which is one of the highest; or, according to some, the very highest mountain in all Germany. On its summit scarce any small shrubs grow, much less trees; and the snow remains frequently there till midsummer, and in some of the northern parts even yet longer. The levels are very fertile in all kinds of grain, pulse, turnips, flax, culinary herbs, and other vegetables and fruits. The mountains afford very valuable plants, with berries of various kinds, particularly crown berries, of which great quantities are preserved; game and wild fowl are plentiful. In 1807, it was annexed to the new kingdom of Westphalia. The inhabitants are Lutherans.

WERNIGERODE, a town of Westphalia, and capital of a county of the same name, situated on a small river, and consisting of three parts: "The Old Town," containing two churches, and about 430 houses, with a house belonging to the county; "The New Town," containing one church, and about 200 houses; and the suburbs, called "Noschenrode," which contain one church, and 150 houses. On a high mountain, directly above the town, is the castle, in which the counts' family archives are kept. The principal business of the town consists in agriculture, brewing, distilling, and manufactures of cloth and stuffs; 12 miles S.W. of Halberstadt. N. lat. 51° 53'. E. long. 10° 52'.

WERNITZ, a river of Germany, which rises about 5 miles S. from Rotenburg, passes by Dinkelsbühl, Wassertrudingen, Oettingen, &c. and runs into the Danube, near Donauwert.

WERNSDORF, a town of Bohemia, in the circle of Saetz; 3 miles N.W. of Kadan.

WERNSTADT, a town of Bohemia, in the circle of Leitmeritz; 10 miles W. of Leypa.

WERO, an island near the coast of Norway. N. lat. 67° 43'. E. long. 9° 10'.

WERPE, a river of Germany, which joins the Sieg, near its source.

WERRA, a river of Germany, which rises in the principality of Coburg, passes by Eisfeld, Hildburghausen, Meinungen, Saltzungen, Vach, Bercka, Gerlungen, Creutzberg, Trefurt, Wanfried, Allendorf, &c. and joining the Fulda at Munden, forms the Weser.

WERRA, a department of the kingdom of Westphalia, composed of Upper Hesse, with the principality of Herfeld; with a population of 254,000 souls. Marburg is the capital.

WERREAR, a circle or district of Hindoostan, lying on the right bank of the Puddar, which separates it from Guzerat, east of Cutch.

WERSALA, a small island near the coast of Finland, at the entrance into the gulf of Bothnia. N. lat. 60° 46'. E. long. 31° 6'.

WERSÉN, a town of Germany, in the county of Tecklenburg; 8 miles N.E. of Tecklenburg.

WERSHOCK, in *Measurement*, a long measure in Russia; 16 wershocks being equal to an arsheen, or 28 English inches; so that 9 arsheens are = 7 English yards, and 4 wershocks = 7 English inches.

WERST, or **WURST**. See **VERST**.

WERT, in *Geography*. See **WEERT**.

WERTACH, a river of Bavaria, which runs into the Lech, a little below Augsburg.

WERTENSTEIN, a town of Switzerland, in the canton of Lucerne; 6 miles W. of Lucerne.

WERTER SEE, a lake of the duchy of Carinthia; 2 miles W. of Clagenfurt.

WERTH, a town of the bishopric of Ratibon; 11 miles N.W. of Straubing.

WERTHA,

WERTHA, a river of Bavaria, which runs into the Lech, near Augsburg.

WERTHEIM, a county of Germany, situated between the electorate of Mentz, and the bishopric of Wurzburg, watered by the Maine, which here receives the Tauber. The ancient counts became extinct in the year 1556. It was afterwards divided among several princes, besides several fiefs of the empire, Bohemia, Wurzburg, and Fulda.—Also, a town of Germany, and capital of a county to which it gives name, at the conflux of the Maine and Tauber. The magistrates are principally Calvinists, but the Roman Catholics and Lutherans have a church in common; 42 miles E.N.E. of Manheim. N. lat. 49° 49'. E. long. 9° 35'.—Also, a town of Germany; 22 miles E. of Frankfort on the Maine.

WERTHER, a town of Westphalia, in the county of Ravensberg; 5 miles N.N.W. of Bielefeld.

WERTINGEN, a town of Bavaria; 14 miles N.N.W. of Augsburg.

WERVICK, or WARWICK, or *Verwick*, a town of France, in the department of the Lys, on the Lys; 3 miles S.W. of Menin.

WESCHNITZ, a river of France, which runs into the Rhine, opposite Worms.

WESCHOLOUEN, a town of Prussia, in Natangen; 12 miles W. of Marggrabowa.

WESE, a river of France, which runs into the Ourt, a little above Chiny.

WESEL, a town of France, in the department of the Roer; transferred in January, 1808, from the duchy of Cleves, on the Rhine. This town was formerly imperial, and governed by its own laws, under the protection of the elector of Brandenburg; 17 miles E.S.E. of Cleves. N. lat. 51° 38'. E. long. 6° 38'.

WESEL, or *Ober Wesel*, a town of France, in the department of the Rhine and Moselle; 20 miles S. of Coblenz.

WESEL Bay, a bay on the south coast of the island of Java. S. lat. 8° 21'. E. long. 113° 42'.

WESELICH, or WEISLING, a town of France, in the department of the Roer; 7 miles S.S.E. of Cologn.

WESEN, a town of Switzerland, in the county of Gaster; 7 miles S. of Uznach.—Also, a town of Holland, in the department of Guelderland; 4 miles S. of Hattem.

WESENBERG, a town of the duchy of Mecklenburg; 42 miles N. of Spandau.

WESENSTEIN, a town of Saxony; 8 miles S.S.E. of Dresden.

WESEP, a town of Holland, on the Vecht; well fortified towards the east. The great business of the inhabitants is to carry fresh water from hence out of the Vecht to Amsterdam, for brewing and other uses, for which traffic they have a particular kind of barges; 4 miles S.E. of Amsterdam.

WESER, a river of Germany, formed by the union of the Werra and Fulda, which passes by Hameln, Rinteln, Minden, Nienburg, Hoya, Bremen, &c. and runs into the German sea, about N. lat. 53° 48'. E. long. 8°.

WESER, a department of the new kingdom of Westphalia, composed of the bishopric of Osnaburg, and part of the county of Schauenburg; the number of inhabitants is 33,400. Osnaburg is the capital.

WESLEY, JOHN, in *Biography*, one of the principal founders of Methodism, was the son of a clergyman, who, educated under a father who was ejected for nonconformity, became a zealous high-churchman, and composed the speech delivered by Sacheverel before the house of lords. John was born at Epworth, in Lincolnshire, of which his father was rector, in June 1703. Educated under pious parents,

he was religiously disposed from his youth. From the Charter-house, where he received his school-education, he was removed to Christ-church college, Oxford; and after taking his first degree, was elected, in 1724, fellow of Lincoln college, and, in 1726, proceeded to the degree of M.A. At this time he was reputed as a good classical scholar, and particularly conversant with dialectics. He was also a poet of no mean talents. Soon after his election to a fellowship, he became Greek lecturer and moderator of the classes, and undertook the instruction of pupils. In 1725 he was ordained by bishop Potter. During some years of his residence at Oxford, he was much esteemed on account of his own character and conduct, and for his attention to discipline and good morals. Upon the perusal of some devotional books, and more especially Law's "Serious Call," he became diffident as to his own religious state, and determined to pay stricter regard to what he conceived to be the essentials of a holy life. In 1729 he associated with a select number of collegians, who met and read together, first the classics on week-days, and on Sundays only divinity; but afterwards their meetings became exclusively religious. They visited the prisoners and sick poor, conversed together on the state of their minds, observed the ancient fests of the church, and communicated every week. This society, which consisted of fifteen members, attracted notice on account of the strictness of their manners and deportment; and became the objects of ridicule to some young men in the university, who denominated them Sacramentarians, the Godly club, and METHODISTS. (See the article.) Some of the seniors of the colleges were alarmed by an introduction of fanaticism; and others encouraged them to proceed, and they received the approbation of the bishop of Oxford. Wesley, after his ordination, settled as assistant to his father at Epworth, who being desirous of retaining this church preferment in his family, wished him to seek interest for obtaining it; but his attachment to Oxford, and to the society which had been there formed, prevailed over every other consideration. In process of time he formed a purpose of going to Georgia, as a missionary; and accordingly he embarked for this province in the year 1735. The prospect of success in this mission seemed at first to be favourable; but several circumstances occurred which changed his views, and induced him to leave Georgia, after a residence of one year and nine months. These circumstances, as some persons have related them, reflect no great honour on Wesley's disposition and character. It appears, however, upon the whole, more especially when we consider Whitefield's success in the same part of the world, that he was less qualified for a missionary than his fellow-labourer. After his return to England, he felt dissatisfied about his own state, and entertained suspicions of the reality of his own conversion, though he had undertaken to convert others. Prepared for a sudden conversion, it actually happened at a place and time, and in a manner, which he has recorded. According to his own account, this memorable event is referred to the 24th day of May, in the year 1738, at a quarter before nine in the evening, when some person at a society in Aldersgate-street was reading Luther's preface to the epistle to the Romans. "He felt his heart strangely warmed. He felt that he trusted in Christ alone for salvation; and an assurance was given to him, that Christ had taken away his sins, and saved him from the law of sin and death." These feelings of assurance, however, were blended with occasional misgivings; and it seems that, in his case, enthusiasm could not instantaneously overpower his philosophical reasonings. His case is far from being singular in the history of persons of the same description. About this

time he took a journey to Germany, in order to derive a further confirmation of his faith from intercourse with congenial spirits at the head-quarters of the Moravians, at Herrnhuth. (See *UNITAS Fratrum*.) After his return to England, in September 1738, he entered on his course of labours; and preached or exhorted, frequently three or four times a day, in prisons and other places of the metropolis, as well as in various parts of the country, where the fervour of his zeal bore proportion to the degree of obloquy which he incurred. His discourses produced wonderful effects, and occasioned in the hearers swoonings, exclamations, convulsions, &c. which have been often the accompaniments of violent emotions. At Bristol, where he had been preceded by Whitfield, he collected large crowds of attendants in the open air. But it was now desirable that a building should be erected for the accommodation of the followers of these popular preachers. In May 1739, the first stone of such an edifice was laid at Bristol; and with this building commenced the absolute and unlimited power which Wesley exercised over his followers. "The direction of the work was first committed to eleven feoffees of his nomination; but as it became necessary for him to engage for the payment of the workmen, and to collect money for this purpose, he visited London, and upon consulting Whitfield and others, he was told, that they would do nothing in the matter, unless he would discharge the feoffees, and take the whole business into his own hands. They gave various reasons for this determination; but one," says Wesley, "was enough, *viz.* that such feoffees would always have it in their power to controul me; and if I preached not as they liked, turn me out of the room that I had built." He, therefore, assembled the feoffees, and with their consent cancelled the instruments made before, and took the whole management into his own hands; and this precedent he ever after followed, so that all the numerous meetings of his classes of Methodists were either vested in him, or in trustees who were bound to give admission into the pulpit either to him, or to such preachers as he shall appoint. Unable to associate clergymen in the prosecution of his plan, which seems to have been his first design, he determined to employ lay-preachers as itinerants to the different societies; and of their talents he formed some judgment by their performances at the meetings for prayer and mere private exhortation. Reserving to himself the nomination of his preachers, his authority was extended as his societies were multiplied. For the use of these societies, he and his brother Charles drew up a set of rules for the direction of their moral and religious conduct, which are said to have been formed upon the purest model of primitive Christianity. A circumstance occurred which threatened injury to the cause of Methodism; but it eventually contributed to its extension, and to the establishment of Wesley without a rival at the head of his own body. Whitfield had imbibed a predilection for the doctrines of the Puritan divines, which were in general Calvinistic. Wesley's opinions were Arminian; so that it was impossible for these two leaders of separate tenets to unite. "The differences between them turned upon the three points, unconditional election, irresistible grace, and final perseverance, concerning which topics their notions varied so much, that Whitfield plainly told his brother reformer, that they preached two different gospels, and that he would not only refuse to give him the right hand of fellowship, but was resolved publicly to preach against him and his brother wheresoever he preached at all." Although they afterwards spoke of each other with esteem, yet their separation was entire and lasting.

The system of discipline formed by Wesley was admirably

contrived both for gaining profelytes, and for extending and making permanent his own influence. As he did not profess to establish a new or distinct sect, he did not interfere with the regular worship either of the establishment or of Dissenters, so that he and his preachers robbed no other ministers of their hearers; and they availed themselves of those seasons, which gave persons that were desirous of attending leisure for this purpose. That he might not be charged with drawing people away from the established church, or other societies of Christians, he did not administer the sacrament of the Lord's Supper in his own chapels, but recommended attendance for this purpose in the established church. (See *METHODISTS*.) The plan of itinerancy was a political measure in the system of Mr. Wesley, as variety serves to excite curiosity, and to increase the number of his followers. It seems also to relieve preachers and hearers, when the flock of the former is small; and it also prevents these missionaries, if they may be so called, from forming permanent connections in any place whither they are sent, and of acquiring an influence, which would be inconsistent with the supremacy of the chief. In order to maintain an union between the members of this body, and to exercise a degree of vigilant inspection with regard to their conduct, Wesley has divided each society into companies of ten or fifteen, called classes, to each of which belongs a leader, whose business it was every week to see every person of his class, and to inquire into his religious state. Many of these companies were divided into smaller parties, called bands, in which the married and single men, and the married and single women, were ranged apart, and they were directed to maintain a confidential intercourse with regard to their character and state with each other. From these bands again were formed select bands, consisting of those who had attained to perfection. Of his love-feasts, &c. we have given an account under *METHODISTS*. Stewards were appointed to receive contributions, which the lowest members were expected to pay, however small the sums, and to superintend the temporal concerns of the societies. In order to preserve a connection between the preachers, as well as to maintain their ultimate subordination to him, Wesley found it useful to summon annually a considerable body of them, in order to take counsel with him, and with one another, concerning the general affairs of the societies. These assemblies were called "Conferences;" and the great number of them at which Wesley had to preside was a principal means of consolidating the whole frame of the society, and maintaining his permanent authority over every part. Wesley and his first followers had many difficulties with which to contend; but their constancy and fortitude, and the apparently beneficial effects of their endeavours in reforming some of the most abandoned members of the community, enabled them ultimately to triumph over all opposition, and to pursue their labours without molestation. On account of his fanaticism and enthusiasm he has suffered ridicule and reproach; and some have even suspected his sincerity in the details which he has given of the extraordinary manifestations of light that have been communicated to him, and the no less extraordinary interpositions of Providence in his favour; alleging that he possessed a degree of understanding which could not be deluded, and, therefore, charging him with a design of deluding others, in order to serve his own purposes. But these are harsh reflections, the justice of which we cannot be induced easily to allow. About the year 1759, Wesley, who had long been the eulogist of a single life, thought proper to marry a rich widow, whose fortune he settled wholly upon herself; but this connection proved an occasion of infelicity,

felicity, and therefore they separated. She died in 1781. Wesley seems to have adopted his father's high-church principles, and he persevered in avowing his connection with the established church, and in preventing, as far as possible, a separation between his followers and the professors of the established religion. During the American war he was a zealous advocate for the measures of government, and he inculcated the duty of submission to the trans-Atlantic Methodists. With this view he published a pamphlet, entitled "A Calm Address to the American Colonies," which was widely disseminated; and though some of his followers were displeased, others were supporters of the authority of Great Britain; whilst, on the other hand, the Methodists in the connection of Mr. Whitefield were generally on the side of American independence. When the contest terminated, it became a matter of some importance to determine what kind of connection should subsist between the American Methodists and their British brethren. Mr. Wesley was induced for this purpose to take a step, which appeared to be a renunciation of the principle of an episcopal church. By his own authority he ordained, with imposition of hands, several preachers who were embarking for America, and consecrated a bishop for the Methodist episcopal church in that country, who, on his arrival, consecrated another, and ordained several as presbyters. He also assumed the same authority with respect to Scotland; "Setting apart," as he says, "three preachers in 1785 to administer in that country the sacraments of baptism and the Lord's supper." In self-defence he alleged, that he had been for several years convinced by lord King's account of the primitive church, that bishops and presbyters are the same order, and have the same right to ordain; but that he declined exercising this right in ordaining his travelling preachers, because he did not wish to violate the established order of the national church to which he belonged. By these measures he offended many in his own connection, and particularly his brother Charles; and it is said, that before his death he repented of his proceedings, and used all his endeavours to counteract the tendency which he then perceived to a final separation from the church.

In a very advanced age, Wesley retained his ability of bearing the fatigue which attended his numerous and extensive labours; and these were continued till within a week of his death, which happened on March 2d, 1791, in the 88th year of his age.

In Wesley's countenance mildness and cheerfulness were blended with gravity, and in old age it was singularly venerable. "In his manners," says one of his biographers, "he was social, polite, conversible, and pleasant, without any of the gloom and austerity common in the leader of a sect. In the pulpit he was usually short and clear, argumentative and sedate, often entertaining, but never attempting the eloquence of the passions. His style in writing was of a similar cast; he expressed himself with facility and precision, and even in controversy seldom elevated his tone beyond a temperate medium. He was placable towards his enemies, charitable, and in pecuniary matters extremely disinterested. His greatest failing was a love of power, which rendered him impatient of contradiction with regard to every thing that concerned his administration as head of his society; yet it is certain that he could not have brought his plans to effect, without a considerable share of absolute authority. It must also be admitted, that he had much of the politician in his character, and could employ artifice when useful for his purposes. That he was thoroughly persuaded of the truth of the system he taught, and had at heart the best interests of mankind, it would be uncandid and unwarrantable

to question; and he will be a memorable person as long as the fabric which he so much contributed to raise shall endure." Lives of J. Wesley, by Hampson, Coke, and Whitehead. Gen. Biog. See METHODISTS.

WESLINGBUHREN, in *Geography*, a town and duchy of Holstein, situated near the coast of the North sea; 53 miles N.W. of Hamburg.

WESOWKA, a town of Poland, in Volhynia; 60 miles N.N.E. of Zytomiers.

WESSEL, JOHN, in *Biography*, an eminent philosopher and divine, was born at Groningen about the year 1409, or 1419; and pursued his studies with incredible ardour both at Zwoll and at Cologne. At the latter place his orthodoxy was suspected, as he proposed difficulties which his masters could not solve. He taught philosophy for some time at Heidelberg, and after visiting several universities, went to Paris, where the disputes ran high between the Realists, Formalists, and Nominalists. He fluctuated between the opinions of these different sects. He predicted the decline of the doctrines of Thomas Aquinas, Bonaventure, and other disputants of that class; and intimated his apprehension that they would be exploded by all true Christian divines, and that the irrefragable doctors themselves would be little regarded. His reputation procured for him the esteem of Francis delle Rovere, general of the Friars Minors, whom he accompanied to the court of Basil, and with whom he returned to Paris, where he resided many years. When his patron was made pope, under the name of Sixtus IV., he paid him a visit at Rome, and being told that his holiness would grant him whatsoever he asked, he limited his request to a Hebrew and a Greek bible from the Vatican. "You shall have them," said the pontiff; "but, simple man that you are! why did not you ask a bishopric?" "Because (answered Wessel) I do not want one;" a reply on which Dr. Jortin has bestowed just applause.

This worthy person died at Groningen in 1489. On his death-bed he lamented to a friend that he had been distressed with doubts concerning the truth of the Christian religion; but at his friend's second visit, he told him with great satisfaction that his doubts were all dissipated. So extraordinary was his learning, that he was distinguished by the appellation of the "Light of the World;" and such was his spirit of free enquiry, that his name is enrolled in the Protestant Catalogue of Witnesses of the Truth. Of his liberal opinions some were, "that the pope might err—that erring he ought to be resisted—that his commands are obligatory only as far as they are conformable to the word of God—and that his excommunications are less to be feared than the disapprobation of the lowest worthy and learned man." We need not wonder then that the monks should have committed all the manuscripts found in his study to the flames. Such as escaped conflagration were printed collectively at Groningen in 1614, and at Amsterdam in 1617. Part of them had been previously printed at Leipzig in 1522, under the title of "Farrago Rerum Theologicarum," with a preface by Martin Luther. Bayle. Mosheim. Brucker by Enfield.

WESSELY, in *Geography*, a town of Moravia, in the circle of Hradisch; 5 miles N.N.E. of Strasnitz.—Also, a town of Bohemia, in the circle of Bechin; 5 miles S. of Sobieslaw.—Also, a town of Moravia, in the circle of Brunn; 36 miles N.W. of Brunn.

WESSEM, or WESSUM, a town of France, in the department of the Lower Meuse; 4 miles S.S.W. of Ruremond.

WESSEN, a town of Austria; 9 miles N.W. of Efferding.

WESSNITZ. See WEISSENITZ.

WEST, GILBERT, in *Biography*, the son of the Rev. Dr. West, prebendary of Winchester, and of a sister of sir Richard Temple, afterwards lord Cobham, was born in 1706, and educated for the church at Eton and Christchurch, in Oxford; but preferring a military life, he served in the army till he received an appointment in the office of lord Townshend, secretary of state, with whom he accompanied king George I. to Hanover. In early life he entertained doubts concerning the Christian religion, which were instilled into him and his cousin Lyttelton by lord Cobham. In 1729 he was appointed a clerk-extraordinary of the privy council; and soon after, being married, he settled at Wickham in Kent. His income was not large, but it was sufficient to entertain his friends Pitt and Lyttelton, who often visited him for literary recreation at Wickham. As a poet, he was known in 1742 by a piece on a dramatic plan, intitled "The Institution of the Order of the Garter," distinguished by pure and elevated morality, and containing passages of elegant fancy and splendid diction. West's "Observations on the Resurrection of Christ," published in 1747, engaged the particular attention of the public, and even induced the university of Oxford to confer upon the author the degree of doctor of laws. This work was so well executed, that we may well regret his not having lived to have completed his design by another work on the evidence of the truth of the New Testament. In 1752 the circumstances of our author were improved by succeeding, when Mr. Pitt became paymaster-general, to one of the lucrative clerkships of the privy council, and his obtaining the place of treasurer to Chelsea hospital. In 1755 he lost an only son, and in the following year his life was terminated by a paralytic stroke, March 1756, at the age of fifty. "Mr. West was a gentleman in manners, agreeable in conversation, and lively though serious. He was regular in the performance of family devotion and in attendance on public worship, and was particularly attached to Dr. Clarke as a preacher."

The other works of Mr. West were, "Translations of the Odes of Pindar, with a Dissertation on the Olympic Games;" "Translations from the Argonautics of Apollonius Rhodius, and the Tragopodagra of Lucian;" "The Abuse of Travelling;" and "Education:" poems in the imitation of the stanza and manner of Spenser; "Iphigenia in Tauris," from Euripides;" and "Original Poems on Various Occasions." Several of these pieces were printed in the collections of Doddsley and Pearch, and also in three distinct volumes, 12mo. 1766; and entitle the author, says his biographer, to a respectable rank among the minor poets. Johnson's Lives. Nichols's Lit. Anecd. Gen. Biog.

WEST, *Occidens, Occafus*, in *Cosmography*, one of the cardinal points of the horizon; diametrically opposite to the east.

West is strictly defined, the intersection of the prime vertical with the horizon, on that side in which the sun sets.

To draw a true west line, see MERIDIAN.

WEST, in *Astronomy*, is chiefly used for the place, in or towards which the sun and stars sink under the horizon. Thus we say, the Sun, Mars, &c. are in the west.

The point in which the sun sets when in the equator, is particularly called the *equinoctial west*, or *point of true west*.

WEST, and *Western*, in *Geography*, are applied to certain countries, &c. situated towards the point of sun-setting with respect to certain others.

Thus, the empire of Rome, anciently, and of Germany, at present, is called the *empire of the West*, or *western empire*, in opposition to that of Constantinople, which is called the *empire of the East*.

The Latin or Roman church is called the *western church*; in opposition to the Greek church.

The French, Spaniards, Italians, &c. are called *western nations*, in respect to the Asiatics; and America, the *West Indies*, in respect of the East Indies.

WEST-*Astion Water*, is a chalybeate water, resembling that of Holt. See Phil. Transf. N^o 461. sect. 20.

WEST *Wind* is also called *Zephyrus*, and *Favonius*. See WIND.

WEST *Saxonlage*, or the law of the West Saxons. See LAW.

WEST *India Companies*. See COMPANY, &c.

WEST *Dial*. See DIAL.

WEST, *Mooring for*. See MOORING.

WEST, in *Geography*, a township of Pennsylvania, in the county of Huntingdon, with 1698 inhabitants.

WEST *Bay*, a bay of the South Pacific ocean, in Cook's Straits, between the two islands of New Zealand.

WEST *Bay*, a bay of the English Channel, on the coast of the counties of Dorset and Devon, of vast extent. It begins west of Portland, and ends at Berry Point near Torbay, according to some; according to others, from Portland to Lyme or Exmouth. The tide is current here nine hours; high water at ten o'clock at new and full moon; an E.S.E. moon makes full sea. The sea off the coast is reckoned the most dangerous part of the Channel, especially on the west, where ships, not aware of the currents, are embayed and driven ashore on the beach. When ships are so deeply embayed, that there is no possibility of getting off, especially at the beginning of the ebb, they may run boldly on the beach, and the mariners are to remain aboard for five or six seas, but may then step on shore with safety; but if they leave the ship instantly it is dangerous and fatal: light-houses have been serviceable for preventing these accidents. Where ships that come from the west neglect to keep a good offing, or are taken short by contrary winds, and cannot weather the highland at Portland, but are driven between the island and the main-land, they perish without remedy; and it has been observed, that more Dutch vessels are lost here than any other, almost every year, especially in winter, which is thought to be owing to an obstinate adherence to old charts, and not allowing for the true variation of the compass. When the variation is W. the true channel course is W. by S. from Dungeness to the Caskets; Portland Bill and the Caskets are 15 leagues asunder nearly in a meridian. Dr. Halley observes, that the navigation up and down the Channel is an E. variation: W.S.W. is the true course. The Channel between Portland and the Caskets is 40 fathoms deep, and in fair weather one may see in that depth the land on both sides: the nearer England the shoalier, the nearer the Caskets the deeper.

WEST *Bay*, a bay at the western extremity of lake Superior. N. lat. 46° 45'. W. long. 91° 45'.—Also, a bay on the N.W. coast of Virgin-Gorda, in the West Indies. N. lat. 18° 23'. W. long. 62° 48'.

WEST *Bethlehem*, a township of Pennsylvania, in the county of Washington, containing 1849 inhabitants.

WEST *Boylston*, a town of Massachusetts, in the county of Worcester, containing 632 inhabitants.

WEST *Bradford*, a township of Pennsylvania, in the county of Chester, with 1219 inhabitants.

WEST *Buffaloe*, a township of Pennsylvania, in the county of Northumberland, containing 2523 inhabitants.

WEST *Calh*, a township of Pennsylvania, in the county of Chester, with 1003 inhabitants.

WEST *Cambridge*, a town of Massachusetts, in the county of Middlesex, containing 971 inhabitants.

WEST Cape, a cape on the W. coast of Tavai-poe-nam-moo, the southernmost island of New Zealand. S. lat. 45° 54'. W. long. 193° 17'.

WEST Cappel, a town of Holland, in the island of Walcheren; 6 miles N.W. of Middleburg.

WEST Chester, a county of New York, containing 30,272 inhabitants.

The following statistical table is founded upon the census of 1810.

Towns.	Population.	Sen. Electors.
Bedford - - -	2,374	241
Cortlandt - - -	3,054	182
East-Chester - - -	1,039	96
Greensburgh - - -	1,862	137
Harrison - - -	1,119	66
Mamaroneek - - -	496	28
Mount-Pleasant - - -	3,119	218
New-Castle - - -	1,291	72
New-Rochelle - - -	996	78
North-Castle - - -	1,366	119
North-Salem - - -	1,204	102
Pelham - - -	267	19
Poundridge - - -	1,249	124
Rye - - -	1,278	85
Scarsdale - - -	259	15
Somers - - -	1,782	142
South-Salem - - -	1,566	186
West-Chester - - -	1,969	105
White Plains - - -	693	68
Yonkers - - -	1,365	93
York-town - - -	1,924	142
	<u>30,272</u>	<u>2,318</u>

It sends three members to the house of assembly. It is situated on the E. side of the Hudson, N. of New York county; bounded N. by Dutchess county, E. by the state of Connecticut, S. by Long island sound and East river, W. by Haerlem river and the Hudson; or by New York county, the state of New Jersey, and the county of Rockland. Its area is about 480 square miles, or 307,200 acres, situated between 40° 47' and 41° 22' N. lat.; 3° and 32' E. long. from New York.

WEST Chester, a post-township of New York, at the S.W. extremity of West Chester county, on East river; 12 miles from New York. Its medial extent from N. to S. may be 4 miles, and from E. to W. about 5, with an area of 20 square miles. It is a valuable tract of land, somewhat stony, with a large proportion of clayey loam, which, with good husbandry, may be rendered productive. West Chester village, situated at the head of the navigation on West Chester creek, contains about 25 dwellings, an episcopal church, a Friends' meeting-house, a school-house, a grist-mill, and about 200 inhabitants. Adjoining to it are a bed of marble and an extensive common. In the township are several manufactories, grist-mills, three houses for worship, one for Friends, one for Episcopals, and one for Dutch Lutherans, and six school-houses, and many elegant country-seats. For its population, &c. see the preceding article.

WEST Chester Borough, a township of Pennsylvania, in the county of Chester, containing 471 inhabitants.

WEST Creek, a river of New Jersey, which runs into the Delaware bay, N. lat. 39° 14'. W. long. 74° 57'.

WEST Fallowfield, a township of Pennsylvania, in the county of Chester, containing 1157 inhabitants.

WEST Gothland, or *Westrogothia*. See **GOTHLAND**.

WEST Harbour, a bay on the S. coast of Jamaica, formed

by a peninsula, called Portland Ridge. N. lat. 17° 48'. W. long. 77°.

WEST Indies, in *Geography* and *Commerce*, comprehends all the islands that lie in the Caribbean sea, between North and South America; and also a few of the neighbouring settlements on the continent. (See *WEST INDIES*.) The larger islands, or greater Antilles, are, Jamaica, belonging to the English, Cuba (Spanish), Porto Rico (Spanish), and St. Domingo (French and Spanish). The smaller islands, or lesser Antilles, called also the Caribbee islands, are divided into *leeward* and *windward* islands. The former are Tortola, the Saints, Barbuda, Antigua, St. Kitt's, Nevis, Montserrat, and Dominica (English), Guadaloupe and Marigalante (French), St. Eustatia and Martin (Dutch), St. Thomas, Santa Cruz, and St. John (Danish), and St. Bartholomew (Swedish). The latter are, Barbadoes, St. Vincent, Grenada, and Tobago (English), Martinico and St. Lucia (French). The islands on the coast of Terra Firma are, Trinidad and Margarita (Spanish), Curassoa and Bonaire (Dutch). The settlements on the continent of South America are, Demerara, Berbice, Essequibo, and Surinam (Dutch). In specifying the monies, coins, currencies, and exchanges of the West Indies, we shall avail ourselves of the arrangement of Dr. Kelly in his valuable work, and class the islands under the five general heads of English, French, Danish, Dutch, and Spanish; premising, that though the several islands and settlements, which we have already enumerated, are subject to various political changes, they nevertheless, for the most part, retain the weights, measures, and denominations of money belonging to the European nations by which they have been colonized.

In the *English* islands, accounts are kept in pounds, shillings, and pence currency; the West India currency being an imaginary money, which varies considerably in its proportion to sterling, so that it is in some places reckoned at 140, and in others 200, for 100*l.* English, more or less. The principal coin circulating in the West Indies is the Spanish dollar, and this seems to be the standard by which the value of all other monies is regulated; and with regard to the proportion between sterling and currency, it should be observed, that although it has been declared by different authorities, yet it is chiefly regulated by the course of exchange with London. Of the *English* islands, the first we shall take notice of is Jamaica. The currency of this island is 140*l.*, and its proportion to sterling is as 7 to 5; so that 1*l.* sterling is = 28*s.* currency, and 1*l.* currency = 14*s.* 3½*d.* sterling. The price of the dollar is 6*s.* 8*d.* currency.

The gold coins current in this island, with their value in currency, appear in the following Table.

		dwt. gr.	Jamaica Currency.		
			<i>l.</i>	<i>s.</i>	<i>d.</i>
Spanish	Doubloon - - -	17 8	5	0	0
	Two pistole piece - - -	8 16	2	10	0
	Pistole - - -	4 8	1	5	0
Portuguese	Half pistole - - -	2 4	0	12	6
	Johanes (called joe) - - -	18 12	5	10	0
	Half joe - - -	9 6	2	15	0
	Quarter joe - - -	4 15	1	7	6
English	Moidore - - -	6 22	2	0	0
	Half moidore - - -	3 11	1	0	0
	Guinea - - -	5 8	1	12	6
	Half guinea - - -	2 16	0	16	3
	Seven-shilling piece - - -	1 19	0	10	10

WEST INDIES.

The deduction for every grain of deficiency of weight is 3d. currency.

The silver coins of Jamaica are dollars, with their halves, quarters, eighths, and sixteenths, passing for 6s. 8d., 3s. 4d., 1s. 8d., 10d., and 5d. currency. Besides, here are *bits* or *bits*, being Spanish reals, and passing for 7½d. currency; so that 10 bits and 5d. currency make a dollar, and 1 bit is worth 5¼d. sterling. *Pistereens*, or two-bit pieces, which are Spanish pecetas, pass for 1s. 3d. currency, and are worth 10¾d. sterling. English shillings and sixpences occasionally pass as pistereens and bits. From the above statement it appears, that the intrinsic par of the currency of Jamaica with respect to sterling is as follows; the calculations being made according to the mint price of gold and silver in England:

According to the	<table style="border-collapse: collapse; border-left: none;"> <tr> <td style="padding: 2px 10px;">English gold coins, 100l. sterling =</td> <td style="padding: 2px 10px;">154 15 0</td> <td rowspan="4" style="font-size: 2em; vertical-align: middle; padding: 0 10px;">}</td> <td rowspan="4" style="vertical-align: middle;">currency.</td> </tr> <tr> <td style="padding: 2px 10px;">Spanish ditto - - - -</td> <td style="padding: 2px 10px;">156 13 2</td> </tr> <tr> <td style="padding: 2px 10px;">Portuguese ditto - - - -</td> <td style="padding: 2px 10px;">155 0 0</td> </tr> <tr> <td style="padding: 2px 10px;">Dollar - - - - -</td> <td style="padding: 2px 10px;">154 11 9</td> </tr> </table>	English gold coins, 100l. sterling =	154 15 0	}	currency.	Spanish ditto - - - -	156 13 2	Portuguese ditto - - - -	155 0 0	Dollar - - - - -	154 11 9
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Spanish ditto - - - -	156 13 2										
Portuguese ditto - - - -	155 0 0										
Dollar - - - - -	154 11 9										

By a law of the Jamaica assembly, the exchange with England was fixed at 40 per cent.; but it has considerably varied: bills being sometimes at a premium of 20 per cent. above the legal exchange, and seldom under 10: dollars occasionally bear a premium of 3 or 4 per cent.

The currency of *Barbadoes* is sometimes reckoned at 135, and sometimes at 140, for 100l. sterling; but it has never been settled by legal authority. The value of the coins has been established by proclamation, and according to these values the par is above 140.

The gold coins current here, with their legal value, are shewn in the following Table.

			Barbadoes Currency.		
			dwt.	gr.	l. s. d.
Spanish	Doubleloon	- -	17	8	4 10 0
	Two-pistole piece	- -	8	16	2 5 0
	Pistole	- -	4	8	1 2 6
Portuguese	Half pistole	- -	2	4	0 11 3
	Johanes (called joe)	- -	18	10	5 0 0
	Half joe	- -	9	5	2 10 0
	Quarter joe	- -	4	14	1 5 0
English	Moidore	- -	6	21	1 17 6
	Half moidore	- -	3	10	0 18 9
	Guinea	- -	5	8	1 10 0
	Half guinea	- -	2	16	0 15 0
	Seven-shilling piece	- -	1	19	0 10 0

N.B.—The deduction for light coin is 2¾d. currency for every grain of deficiency.

The current silver coins are dollars, with halves, quarters, eighths, and sixteenths, passing for 6s. 3d., 3s. 1½d., 1s. 6½d., 9½d., and 4¾d. currency. Also bits, which are Spanish reals, and which pass for 7½d. currency; thus, 10 bits make 1 dollar, and 1 bit is worth 5¼d. sterling. *Pistereens*, or two-bit pieces, which are Spanish pecetas, pass for 1s. 3d. currency. There are also French bits, called *crimbal*, or *isle du vent bits*, which pass for 7½d. currency.

The Barbadoes currency compared with sterling is,

According to the	<table style="border-collapse: collapse; border-left: none;"> <tr> <td style="padding: 2px 10px;">English coins, 100l. sterling =</td> <td style="padding: 2px 10px;">142 17 2</td> <td rowspan="4" style="font-size: 2em; vertical-align: middle; padding: 0 10px;">}</td> <td rowspan="4" style="vertical-align: middle;">currency.</td> </tr> <tr> <td style="padding: 2px 10px;">Spanish ditto - - - -</td> <td style="padding: 2px 10px;">141 0 0</td> </tr> <tr> <td style="padding: 2px 10px;">Portuguese ditto - - - -</td> <td style="padding: 2px 10px;">140 13 7</td> </tr> <tr> <td style="padding: 2px 10px;">Dollar ditto - - - - -</td> <td style="padding: 2px 10px;">144 19 6</td> </tr> </table>	English coins, 100l. sterling =	142 17 2	}	currency.	Spanish ditto - - - -	141 0 0	Portuguese ditto - - - -	140 13 7	Dollar ditto - - - - -	144 19 6
English coins, 100l. sterling =	142 17 2	}	currency.								
Spanish ditto - - - -	141 0 0										
Portuguese ditto - - - -	140 13 7										
Dollar ditto - - - - -	144 19 6										

In the English leeward islands the dollar is reckoned at 9s., and this rate is generally called the leeward currency.

A small circular piece cut out of the centre of the dollar, about one-twelfth of its value, in order to prevent its exportation, is allowed to pass for one-eighth, and is stamped by authority with the initials of the island.

The dollar, thus cut, passes for 8s. 3d. currency; it is called the "cut dollar," by way of distinction from the whole or "round dollar." The piece taken out is sometimes called the "bit," and sometimes the "moco," which moco is, in some places, one-fourth of the dollar, and in others one-eighth. In these islands there are small copper coins, called *stamps*, *dogs*, and *half dogs*, valued as in the following Table.

		Leeward Currency.		
		l.	s.	d.
2 Half dogs	- make 1 Dog	=	0	0 1½
1½ Dog	- - - 1 Stampe	=	0	0 2¼
6 Dogs or 4 stamps	- 1 Bit	=	0	0 9
1½ Bit	- - - 1 Moco	=	0	1 1½
11 Bits	- - - 1 Cut dollar	=	0	8 3
12 Bits or 8 mocos	- 1 Round dollar	=	0	9 0
5 Round dollars	- 1 Guinea	=	2	5 0
8 Cut dollars	- 1 Joe	=	3	6 0
16 Round dollars	- 1 Doubleloon	=	7	4 0

For a deficiency of weight, an allowance is made of 4¾d. currency for English grain. The exchange with London is generally about 200 per cent.

In the English windward islands the currencies are nearly the same as the former, allowing for some local regulations and customs.

In the French islands accounts are kept by the French settlers in livres, sols, and deniers; and by the English (particularly in exchanges) in pounds, shillings, and pence currency; the livre and shilling being of the same value.

The currency is the same as that of the English leeward and windward islands: but the names of the coins are different; the dog being called the *noir*, the *stampe* the *tempé*, the bit the *escalin*, and the dollar the *gourde*.

The value of the coins appears in the following Table.

		Leeward Currency.		
		liv. sol. den.	l.	s. d.
The noir, or dog	- - -	0 2 6	0 0	1½
The tempé, or stamp	- - -	0 3 9	0 0	2¼
The trois tempés	- - -	0 11 3	0 0	6¾
The escalin, or bit	- - -	0 15 0	0 0	9
The trois petites pieces	- - -	1 2 6	0 1	1½
The piece de trente sols, or pistereen	- - -	1 10 0	0 1	6
The moco	- - -	2 5 0	0 2	9
The gourde or dollar	- - -	9 0 0	0 9	0
The ecu of six livres	- - -	9 17 6	0 9	10½
The Louis d'or	- - -	40 10 0	2 0	6
Guinea	- - -	45 0 0	2 5	0
Napoleon of 40 francs	- - -	66 13 4	3 6	8
Doubleloon	- - -	144 0 0	7 4	0

The following gold coins are taken by weight.

Portugal pieces, at	- - - -	22 livres per gros
Counterfeit ditto, coined in America, at 20 ditto per gros	- - - -	French and Spanish coins deficient in weight, at
		} 19l. 15s. per gros
English ditto at 8 livres, 8 sols per dwt., that is, 7 sols per English grain.	- - - -	

WEST INDIES.

In the French part of St. Domingo, or Hayti, accounts are mostly kept in dollars and cents, as in the United States. The monies in circulation here are nearly the same as in the leeward islands. Dollars are valued at 4s. 6d. sterling, with halves and quarters in proportion: 11 escalins pafs for 1 dollar, and 1 escalin is reckoned at 9 cents. Doubloons pafs for 16 dollars; joes for 8 ditto; French crowns for 1 dollar 9 cents, and the half-crowns in proportion; French pieces of 5 francs pafs for 9 escalins, or 81 cents.

In the Dutch colonies of St. Eustatia, St. Martin, Curaçoa, accounts are kept in pieces of eight; that is, piaftres current of 8 reals or schillings, each real being subdivided into 6 stivers.

The piaftre gourde or Spanish dollar paffes for 11 reals or bits; and thus the current piaftre is worth 3s. 5d. sterling, reckoning the dollar at 4s. 8d. sterling.

The joe paffes here for 11 piaftres current; the Spanish single pistole for 4½ piaftres, more or less; the other Spanish and Portuguefe gold coins in proportion.

In the settlements of Surinam, Berbice, Demerary, and Essequibo, accounts are kept in guilders of 20 stivers; the silver being divided by some into 8 duits, and by others into 12 pennings.

All the coins of Holland circulate here, and are mostly reckoned at 20 per cent. above their value in Dutch currency.

The following is their general rate, as well as that of other monies.

<table style="width: 100%; border-collapse: collapse;"> <tr><td>10 Dubbelties =</td><td style="text-align: right;">gdrs. stiv. 1 0</td></tr> <tr><td>The bit - =</td><td style="text-align: right;">0 5</td></tr> <tr><td>Seftehalf - =</td><td style="text-align: right;">0 5½</td></tr> <tr><td>Schilling - =</td><td style="text-align: right;">0 6</td></tr> <tr><td>Guilder - =</td><td style="text-align: right;">1 4</td></tr> <tr><td>Dalder - =</td><td style="text-align: right;">1 10</td></tr> <tr><td>Rixdollar - =</td><td style="text-align: right;">3 0</td></tr> </table>	10 Dubbelties =	gdrs. stiv. 1 0	The bit - =	0 5	Seftehalf - =	0 5½	Schilling - =	0 6	Guilder - =	1 4	Dalder - =	1 10	Rixdollar - =	3 0	<table style="width: 100%; border-collapse: collapse;"> <tr><td>Spanish dollar =</td><td style="text-align: right;">gdrs. stiv. 3 0</td></tr> <tr><td>Ducatoon - =</td><td style="text-align: right;">3 3</td></tr> <tr><td>Gold ducat =</td><td style="text-align: right;">6 6</td></tr> <tr><td>Guinea - =</td><td style="text-align: right;">14 10</td></tr> <tr><td>Ryder - =</td><td style="text-align: right;">16 16</td></tr> <tr><td>Joe - =</td><td style="text-align: right;">22 0</td></tr> <tr><td>Doubloon - =</td><td style="text-align: right;">42 to 44</td></tr> </table>	Spanish dollar =	gdrs. stiv. 3 0	Ducatoon - =	3 3	Gold ducat =	6 6	Guinea - =	14 10	Ryder - =	16 16	Joe - =	22 0	Doubloon - =	42 to 44
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The chief circulating medium here is paper, issued by government.

In 1809 a new silver coinage was minted at the Tower of London for these colonies, consisting of pieces of 3, 2, 1, ½, and ¼ guilders. The larger piece weighs 15 dwt.; and is 1 oz. 6 dwt. worse than English standard. Its value therefore is, 3s. 5d. sterling, or computing it as the dollar is now rated in the West Indies (*i. e.* at 4s. 8d.), its value is 3s. 8¼d., and the smaller pieces in proportion. They are marked on the reverse, COLONIES OF ESSEQUIBO AND DEMERARY TOKEN; and the king's head is on the obverse.

The exchange with London should be about 12 guilders for 1l. sterling, but it varies considerably above this, even to 20 guilders and upwards.

In the Danish islands accounts are kept in piaftres or rix-dollars current (called also pieces of eight), subdivided into 8 schillings or bits, and each bit into 6 stivers: accounts are also kept in dollars of 100 cents, as in America. The silver coins struck for the Danish islands are quadruple, double, and single bits, and pieces of 1 and 3 stivers. The Spanish dollar paffes for 12½ bits, and each bit for 6¼ stivers. The leeward currency is used in the Danish islands in the purchase or negociation of bills on England: gold is valued at 1 dollar per dwt. or 4½d. currency per English grain.

The monies, coins, weights, and measures of the Spanish islands are the same as those in Spanish America, or Mexico; accounts being kept in pesos or dollars of 8 reals, subdivided into 16 parts, and also into 34 maravedis de Plata Mexicanos. The gold coins are doubloons of 8 escudos d'oro, worth 15 pesos; halves and quarters in proportion. The silver coins are, pesos Mexicanos or dollars, with halves and quarters,

called pecetas Mexicanas; also eighths and reals, and sixteenths, in due proportion.

Trinidad, having been for many years in the possession of the English, has adopted the denominations of money of the English islands. Accounts therefore are here kept in pounds, shillings, and pence leeward currency; and also in dollars and bits, the bit being the 9th part of a dollar.

There are here silver pieces of half bits and quarter bits. The Spanish, Portuguefe, and English gold coins pafs as follows in Trinidad.

			Leeward Currency.		
	dwt. gr.	dol. bits.	l.	s.	d.
Doubloon -	17 8	15 8	7	4	0
Half ditto -	8 16	7 8½	3	12	0
Pistole -	4 8	3 8¼	1	16	0
Half ditto -	2 4	2 0	0	18	0
Joe -	7 12	6 8	3	2	0
Guinea -	5 8	4 8	2	4	0
Half ditto -	2 16	2 4	1	2	0
One-third ditto	1 19	1 5¾	0	14	8

Gold here is valued at 8s. 3d. currency per dwt. or 4½d. per grain.

The weights and measures here are the same as in England, except that the cwt. is reckoned only 100 lbs. avoirdupois.

The monies and currency of St. Bartholomew island are the same with those of the other leeward islands.

The regulations to which the West India exchanges are subject are as follow. When bills drawn in the West Indies on London are not duly honoured, they are returned to the drawer, with the following charges.

	Damages.	Interest per Annum.	Time how charged.
Jamaica	8 per cent.	6 per cent.	{ from date of the bill. { from the time of presentation with protest.
Barbadoes	10 ditto	6 ditto	
Grenada	10 ditto	6 ditto	
St. Vincent	10 ditto	8 ditto	{ from the bill falling due.
Tobago	10 ditto	8 ditto	
Trinidad	10 ditto	6 ditto	{ from date of the protest.
Dominica	10 ditto	6 ditto	
Nevis	10 ditto	8 ditto	
Montserrat	10 ditto	8 ditto	
Antigua	10 ditto	8 ditto	
St. Kitt's	10 ditto	8 ditto	
Tortola	10 ditto	8 ditto	
Demerara	25 ditto	6 ditto	
Essequibo			
Berbice			
Surinam	10 ditto	10 ditto	{ from date of the protest.
St. Thomas			
St. John			
Santa Cruz			

There are occasionally other charges besides the above, such

such as postage, notarial expences, and difference of exchange.

If a bill, drawn in the West Indies on any part of Great Britain, be noted for non-acceptance, the holder may oblige the drawer, by legal process, to give security in the island for the amount, without waiting for the bill being protested for non-payment. See Kelly's Cambist, vol. i.

WEST Island, in *Geography*, one of the smaller Philippine islands, near the south coast of Mindoro. N. lat. $12^{\circ} 18'$. E. long. $121^{\circ} 12'$.—Also, a small island at the east entrance of the straits of Sunda. S. lat. $5^{\circ} 27'$. E. long. $106^{\circ} 20'$.—Also, a small island in the East Indian sea, near the fourth coast of Cumbava. S. lat. $8^{\circ} 49'$. E. long. $119^{\circ} 2'$.

WEST Kirk, a town of the island of Westra, in a bay on the fourth coast. N. lat. $59^{\circ} 8'$. W. long. $2^{\circ} 51'$.

WEST Houghton, a township in the parish of Dean, and county of Lancaster, England, contained, in 1811, 663 houses and 3810 inhabitants.

WEST Penn, a township of Pennsylvania, in the county of Northampton, containing 947 inhabitants.

WEST Point, a town of Virginia, on the York river; 35 miles E. of Richmond. N. lat. $37^{\circ} 30'$. W. long. $76^{\circ} 56'$.

WEST Point, a town of New York, on the right bank of the Hudson river, in the county of Orange. This was a post of great consequence, especially with respect to the communication between the northern and the middle colonies, and the possession very desirable to the British general, who entered into a treaty with general Arnold the commander to betray it. The adjutant-general of the British army, major André, was employed by sir Henry Clinton as the agent on this business, and being discovered, he was executed as a spy; 42 miles N. of New York. N. lat. $41^{\circ} 23'$. W. long. 74° .

WEST Point, a cape at the western extremity of the island of Anticosti. N. lat. $49^{\circ} 50'$. W. long. $64^{\circ} 30'$.

WEST River, a river of Virginia, which runs into Black bay, N. lat. $36^{\circ} 30'$. W. long. $76^{\circ} 17'$.—Also, a river of Maryland, which runs into the Chesapeake, N. lat. $38^{\circ} 54'$. W. long. $76^{\circ} 42'$.—Also, a river of the province of Maine, which runs into Machias bay, N. lat. $44^{\circ} 45'$. W. long. $67^{\circ} 19'$.

WEST River, or *Wantassic*, a river of Vermont, which runs into the Connecticut, N. lat. $42^{\circ} 50'$. W. long. $73^{\circ} 31'$.

WEST River Mountain, a mountain of New Hampshire, near West river.

WEST Town, a township of Pennsylvania, in the county of Chester, with 790 inhabitants.

WEST Wain, the west shore of Hudson's bay.

WESTBROUGH, a town of Massachusetts, incorporated in 1717, in the county of Worcester, containing 1048 inhabitants; 33 miles W. of Boston.

WESTBURY, a market-town and borough in the hundred of the same name, and county of Wilts, England, is situated at the distance of 24 miles N.W. by W. from Salisbury, and 97 miles W. by S. from London. Nothing is known with certainty of its history, till the reign of Edward I., when it was constituted a corporate town by charter, under the jurisdiction of a mayor, recorder, and twelve capital burgesses. Westbury sends two members to parliament, and has done so regularly since the 27th year of Henry VI., who renewed its charter of incorporation, and bestowed upon it the additional privilege of being represented in the national councils. The right of election is in the holders of burgage tenures, being resident within the borough, and not receiving alms: the mayor is the re-

turning officer. The town consists principally of one long street, running nearly in a direction north and south. According to the population return of the year 1811, it contained 351 houses, and 1790 inhabitants, who were chiefly engaged in the manufacture of woollens. A market is held weekly on Fridays; and two fairs annually, when there is usually a large supply of cattle, horses, sheep, pigs, cheese, &c. The borough and hundred of Westbury form only one parish: for the former, a court-leet is held by the mayor in November annually; and for the latter, one in May by the steward of the lord of the manor, at which two high constables are appointed for securing the public peace. The only public buildings in this town which demand particular notice, are the town-hall and the church. The hall is a convenient edifice, in which the borough-courts are held: it is situated near the centre of the town, and is also appropriated in part as a wool-hall. The church is a large ancient structure of stone, with a tower in the middle. In it are several monuments in honour of persons of considerable note.

About a mile to the south of Westbury is the village of Leigh, commonly called Westbury-Leigh; supposed by several antiquaries to be the place designated in Asser by the word *Ægges*, where king Alfred encamped on the night previous to the battle of Ethandune.

Heywood house, situated about two miles due north from Westbury, was built in the reign of king James I., by James, lord Ley, afterwards created earl of Marlborough. It was long possessed by the family of Phipps; but is now the property and seat of Abraham Ludlow, esq.—*Beauties of England and Wales*, vol. xv. Wiltshire. By J. Britton, F.S.A. 1814.

WESTBURY, a village in the hundred of Ford, and county of Salop, England, situated 8 miles W. by S. from Shrewsbury. In this village is a respectable free-school; and in the church, among other monuments, is one raised to the memory of general Severne, who inherited Wallop-hall, in this parish. About two miles S.W. of Westbury is Cawfe, or Caux-Castle, which is supposed to have been erected by Roger Corbett, who held of earl Roger de Montgomery a tract of land consisting of thirty-nine manors. It is conjectured that he gave the above name to this his capital seat, in allusion to a castle in the Pays de Caux, in Normandy. As he and his son probably joined with Robert de Belesme in his rebellion, the castle is supposed to have been forfeited to Henry I., who gave it to Paris Fitz-John, from whom it was taken by the Welsh. It was restored to the original lords, and in the first of king John a weekly market was obtained for it, at the instance of Robert Corbett. Its proximity to the Welsh frontiers rendered its tenure uncertain, and we find that it was again seized by the Welsh, and restored by Henry III. In the reign of Edward III., the male line of the family becoming extinct, the castle was transferred, by marriage of a daughter of the house, to the Staffords, earls of Stafford; on the execution of the last of whom, Edward, duke of Buckingham, it was forfeited to the crown, but was restored to his son Edward. It was alienated in the reign of Elizabeth to Robert Harcourt, from whom it descended to lord viscount Weymouth. The site of this castle is perhaps one of the most lofty and commanding in the whole range of the Salopian frontier. It is an insulated ridge, rising abruptly from a deep ravine on one side, and sloping towards a vast valley, bounded by the Stiper-stones on the other. The keep-mount is singularly steep and towering; it must have been ascended by steps, or by a winding path, but no traces of either at present remain: part of a well is still distinguishable;

inguishable; the castle itself is nearly destroyed. Parts of one of the entrance-gateways, evidently of a more recent date than the original castle, are still to be discerned.—*Beauties of England and Wales*, vol. xiii. Shropshire. By R. Rylance, 1811.

WESTBURY, a township of Lower Canada, on the river St. Francis.

WESTENBERG, a town of the marggravate of Anspach; 6 miles N.E. of Anspach.

WESTENSEE, a lake of the duchy of Holstein; 8 miles E. of Rendsburg.—Also, a town of the duchy of Holstein, on the side of the lake of the same name; 8 miles S.E. of Rendsburg.

WESTERBURG, a town of Germany, which gives name to a lordship, situated on the Westerwald. The lords of Westerburg succeeded the counts of Leiningen. They are counts of Leiningen and lords of Westerburg; 16 miles W.N.W. of Weilburg.

WESTERHAM, a market-town in the hundred of Westerham and Eden-bridge, late of Sutton, and county of Kent, England, is situated near the confines of the county towards Surrey, at the distance of 5 miles W. from Seven-Oaks, and 22 miles S.E. by S. from London. The manor was given by Edward I. to the abbey at Westminster, for the performance of certain religious services for the repose of the soul of queen Eleanor. He also granted several privileges to the abbot, which were confirmed by Edward III., who also gave permission to hold a weekly market at Westerham, which is still continued. After the dissolution, Henry VIII. conveyed these estates to sir John Gresham, younger brother of sir Thomas Gresham, the founder of the Royal Exchange: and his descendant, sir Marmaduke Gresham, sold this manor to the Wardes of Squerries, a respectable seat in this parish, near the west end of the town; and John Warde, esq. is now the owner. Westerham is stated, in the population return of 1811, to contain 272 houses, and 1437 inhabitants. The market is now held on Wednesday; and here are two annual fairs. The church, a spacious edifice, contains a great variety of sepulchral memorials; among which is a neat cenotaph in commemoration of major-general James Wolfe, a native of this town, who was slain before Quebec in 1759. This town also gave birth to Dr. Benjamin Hoadley, who, in the last century, was successively bishop of Bangor, Hereford, Salisbury, and Winchester.

Some singular land-slips are recorded by Haisted, as having happened at different periods in this parish. The first which is mentioned occurred in 1596, near Oakham-hill, about a mile and a half southward from the town; where about nine acres of ground continued in motion for eleven days; some parts sinking into pits, and others rising into hills. A similar occurrence took place in 1756, at Toy's-hill, about a mile and a half to the east of the town, where a field of two acres and a half underwent considerable alterations of surface, from an almost imperceptible motion.—*Beauties of England and Wales*, vol. viii. Kent. By E. W. Brayley, 1808. Haisted's History of Kent, 1778.

WESTERHAUSEN, a town of the bishopric of Halberstadt; 3 miles E. of Regenstein.

WESTERLEY, a town of America, in Rhode island; 30 miles S.S.W. of Providence.

WESTERLOO, a town of France, in the department of the Two Nethes; 15 miles E.N.E. of Malines.

WESTERMO, a town of Sweden, in Sudermanland; 62 miles W. of Stockholm.

WESTERN *Amplitude, Church, Horizon, and Ocean.* See the several articles.

WESTERN, in *Geography*, a town of the state of Massachusetts, in the county of Worcester, containing 1014 inhabitants; 20 miles W. of Worcester.

WESTERN *Islands.* See AZORES.

WESTERN *Islands.* See HEBRIDES.

WESTERN *Reef*, rocks in the Spanish Main, near the Mosquito shore. N. lat. $14^{\circ} 42'$. W. long. $82^{\circ} 25'$.

WESTERNACH, a river of Bavaria, which runs into the Mindel, 2 miles N. of Mindelheim.

WESTEROS, or WESTESAS, or *Western Arosia*, so called to distinguish it from Odra Aros, or Eastern Arosia, the ancient name of Upsala, a town of Sweden, and capital of Westmannland, situated on a small river close to the lake Mæler. This is esteemed by the native writers a place of high antiquity; and they derive its appellation, by a fanciful etymology, from the river Ar, and Os, a mouth, and suppose it alluded to by Tacitus, and by Jornandes the Gothic historian. However this be, the name occurs in the earliest times of Swedish history. Westeros carries on a considerable commerce with Stockholm across the lake Mæler; particularly in copper and iron from the mines, which abound in the province of Westmannland. It is a large straggling town, composed of wooden houses, and contains the ruins of an ancient palace, formerly inhabited by the kings of Sweden. It is a bishop's see; and the cathedral, which is built with brick, is celebrated for the tower, esteemed the highest in the kingdom; the lower part of this tower is square, and supports an octagon spire, covered with copper. Within this cathedral is the tomb of Eric XIV. Westeros has often suffered much by fire, particularly in 1714. It is 36 miles W.S.W. from Upsal. N. lat. $59^{\circ} 36'$. E. long. $16^{\circ} 30'$.

WESTEROS, a township of New York, in Oneida county, bounded N. by Boonville, E. by Steuben, S. by Floyd and Rome, W. by Lee, which was erected from the W. part in 1811. It is watered by small head waters of Mohawk river, and has plenty of mill-seats. The soil, surface, and products, are similar to those of Steuben and the adjoining towns. In 1810, the population was 2416, and the number of electors was 275. The lands are well cultivated and productive. The inhabitants are rich, and are clothed in household manufacture.

WESTERWALD, a district of Germany, in the north part of Wetteraw, or Wetteravia.

WESTERWALD *Earth*, a kind of earth mentioned by Agricola, of a whitish-yellow colour, of a like nature to the terra Silesiaca, but preferable to it, as yielding more salt. He tells us, that it dissolves silver so much better than other menstrea, as to render it potable, and capable of being prepared into a useful medicine in cephalic cases. Boyle's Works, vol. i. p. 501.

WESTERWYCK, in *Geography*, a sea-port of Sweden, in the province of Smaland, situated in a bay of the Baltic. This bay is called Sparefund; and near it is a custom-house, where all homeward and outward bound ships are searched. Westerwyck formerly stood two Swedish miles higher up in the country, on the spot where the market-town of Gammel now stands. It has a good harbour, a commodious quay, and a cloth manufacture, and carries a brisk trade in ship timber, and all sorts of naval stores; 68 miles N. of Calmar. N. lat. $57^{\circ} 45'$. E. long. $16^{\circ} 24'$.

WESTEY, a township of Ohio, in the county of Washington, containing 172 inhabitants.

WESTFIELD, a river of Massachusetts, which runs into the Connecticut, 4 miles S. of Springfield.—Also, a town of the state of Massachusetts, in the county of Hampshire, containing 2130 inhabitants; 6 miles W. of Springfield.

field.—Also, a post-town of New York, on the east side of lake George; 6 miles S. of Ticonderoga.—Also, a township of New York, in Richmond county, in Staten island. At its southern extremity in the S.W. is a ferry of three-quarters of a mile to Amboy, in New Jersey. It has one church near the centre, and well cultivated land. The whole population in 1810 was 1444, and the number of electors 139.—Also, a town of Vermont, in the county of Orleans, containing 149 inhabitants.—Also, a town of New Jersey, in the county of Essex, containing 2152 inhabitants; 8 miles W. of Elizabethtown.

WESTFORD, a town of Vermont, in Chittenden county, containing 866 inhabitants.—Also, a post-town of Massachusetts, in the county of Middlesex, containing 1330 inhabitants; 28 miles N.W. of Boston.—Also, a township of New York, in Otsego county; 8 miles S.E. of Cooperstown, erected in 1808 from the N.W. part of Worcester. Its surface is broken by hills and valleys, but has much rich mould in the valleys. The hills are adapted to grazing, and it has many tracts of meadow land. Its timber consists of maple, beech, ash, elm, bass-wood, and pine; and the whole is irrigated abundantly by springs and brooks. In 1810 the whole population consisted of 1215 persons, and the number of electors was 73, and that of taxable inhabitants 177.

WESTGATE BAY, a bay of the Thames, on the coast of Kent, W. of Margate.

WEST GREENWICH, a town of Rhode island, in the county of Kent, with 1619 inhabitants.

WESTHAM, a town of Virginia; 4 miles N.W. of Richmond.

WESTHAMPTON, a post-town of New York, in the south-east part of Long island.—Also, a township of Massachusetts, in the county of Hampshire, containing 793 inhabitants; 7 miles W. of Northampton.

WEST HANOVER, a township of Pennsylvania, in the county of Dauphin, containing 2461 inhabitants.

WESTHAVEN, a township of Connecticut; 3 miles W.S.W. of Newhaven.

WESTHOFEN, a town of France, in the department of Mont Tonnerre; 5 miles N.N.W. of Worms.—Also, a town of France, in the department of the Lower Rhine; 12 miles W. of Straßburg.

WESTHOVEN, a town of Germany, in the county of Mark, at the foot of a mountain near the Roer; once the domain of the celebrated Witikind, and possessed of considerable privileges; 4 miles S.W. of Schwiert.—Also, a town of Vermont, in the county of Rutland, containing 679 inhabitants.

WESTING, in *Navigation*, the same with departure.

WESTLAND, in *Geography*, a town of Ohio, in the county of Guernsey, with 250 inhabitants.

WESTMAES, a town of the island of Beyerland; 12 miles W. of Dort.

WESTMAN, or WESTMONIA, an island in the North sea, near the coast of Iceland. N. lat. $63^{\circ} 20'$. W. long. $20^{\circ} 28'$.

The Westman islands suffered very much about the commencement of the seventeenth century, by the piracies of the Algerines; almost their whole population being destroyed or carried into captivity. In 1627 a large body of Algerine pirates landed on various parts of the southern coast of Iceland; and not satisfied with the booty they obtained, murdered between forty and fifty of the inhabitants, and carried off nearly four hundred prisoners of both sexes. These unfortunate captives, transported to Algiers, were exposed there to so much wretchedness, that nine years afterwards, when the king of Denmark obtained their liberty by ran-

som, only thirty-seven out of the whole number were found to be surviving; of these, thirteen succeeded in reaching their native land. A priest named Olaus Egilson, a captive, and released in 1629, left a MS. relation of this event, which has been since published in Danish.

WESTMAN, a town on the W. coast of the island of Stromoe.

WEST MANCHESTER, a township of Pennsylvania, in the county of York, containing 978 inhabitants.

WESTMANNLAND, or WESTMANIA, a province of Sweden, bounded on the north by Dalecarlia, on the east by Upland, on the south by Sudermanland, Nericia, and the Mæler lake, and on the W. by Warmeland; about 110 miles in length, and 80 in breadth where widest. The soil is fertile, and consists mostly of arable lands, with meadows, pastures, and very fine woods in proportion; and it is reckoned the most famous province in the kingdom for mines. The iron trade carried on by the inhabitants of Westmannland, is the most considerable in all Sweden: the quantity of iron exported annually from Westeros, Arboga, and Kioping, is very large. The south part of the province chiefly consists of arable and meadow lands, and supplies the inhabitants of the mine districts with corn; and the northern parts abound in mine-works, and fine woods. Westmannland is well watered, both with rivers and lakes, which yield a vast plenty of fish; and the Mæler lake is a great advantage to its commerce, as it opens a passage from this province to Stockholm. The chief subsistence of the inhabitants is derived from agriculture and the mines, breeding of cattle and fishing. The wood, hammer-mills, &c. also employ a great many hands.

WEST MARLBOROUGH, a township of Pennsylvania, in the county of Chester, containing 917 inhabitants.

WESTMEATH, a county of Ireland, which formerly was a part of the kingdom of Meath, but on the division into counties was separated from it, and both now form a part of the province of Leinster. It has Cavan on the N., Meath on the E., the King's county on the S., Roscommon, from which it is separated by the Shannon, and Longford on the W. Its greatest extent from E. to W. is 33 Irish (42 English) miles, and from N. to S. 27 Irish (34 English) miles. Its area measures 231,538 acres, or 361 square miles Irish, equal to 371,979 acres, or 577 square miles English measure. The number of parishes is 62, of which 21 have churches, and all but three are in the diocese of Meath. The population was computed by Dr. Beaufort to be 69,000. No part of this country is embarrassed with mountains, but a great number of acres are rendered unproductive by large lakes and extensive bogs; yet the convenience of fuel, the abundance of gravelly hills, and the variety of prospects which arise from these beautiful lakes, and the undulating form of the surface, render it a very pleasant and healthful country. The soil is in general light, but in some places deep and rich; and though there is more of it kept under grass than employed in tillage, yet the plough is by no means neglected; for after supplying the home consumption, the farmers of this county largely contribute to the exportation of oats from Drogheda. The Royal Canal from Dublin to Tarmonbury, on the Shannon, was to pass through this county, and it has been carried as far as Mullingar; but the difficulties into which the company has fallen make it doubtful when the original design will be completed. Westmeath is remarkably well watered. Besides the Shannon, which forms part of its western boundary, the Inny and Brosna, two rivers of considerable extent, pass through its lakes, and insulate the greater part of it. The Inny rises in the county of Cavan, and first enters Lough Shelin, which separates that county

from Westmeath; then in its course passing through the loughs Derveragh and Iron, it is at length lost in that vast expanse of the Shannon, called Lough Ree, or the Royal Lake. The Brosna, rising in Lough Iron, flows from it to Lough Hoyle, after quitting which it passes the town of Mullingar; it then expands into Lough Ennel, and when again contracted, flowing by the town of Kibeggan, it enters the King's county, through which it proceeds to the Shannon. As Westmeath is nearly central, so its streams flow in both directions. Those which have been already mentioned, joining the Shannon, are mixed with the Atlantic ocean; whilst other small streams, being collected in the river Dele, take an eastern direction, and being united with the Boyne, flow to the Irish sea.

Besides Lough Shelin on the north, and Lough Ree on the western boundary, there are six considerable lakes in this county, and several small ones. These are well stored with fish of various kinds, and afford a number of beautiful prospects; yet it is to be regretted that so many acres should be almost an unprofitable waste. The fish found in these lakes are, perch, pike, bream, tench, trout, and very fine eels. The trout are often of ten pounds weight, and as red as a salmon. Such is the abundance, that Mr. Young tells us that a child with packthread and a crooked pin is able to catch perch enough in an hour to support a family for a day. This territory once belonged to Mortimer, earl of March, who married the daughter and heiress of Lionel, duke of Clarence, third son of Edward III. This nobleman resided much in Ireland, and was probably induced by the beauties of the situation to build a palace at Fahatty, on the banks of Lough Derveragh, one of the finest of these lakes, the remains of which were said above a century ago to retain "the lineaments and footsteps of ancient state and magnificence." When Richard II. was deposed by Henry of Lancaster, Mortimer was the next in succession to the throne, and he found it necessary to conceal himself, which he did by retiring to Fahatty. By a marriage with his daughter, Richard, duke of York, succeeded to his Irish property, and to his right of succession. This nobleman resided in Ireland for some years as lord-lieutenant, before circumstances enabled him to urge his claim to the crown, which, after a long and bloody civil war, was obtained by his son. The attachment of the settlers in Ireland to this family was shewn in the reign of Henry VII., by their readily embracing the cause of Simnel and Warbeck.

Mullingar is the shire town of Westmeath; but Athlone is a place of more consequence. For an account of these, and of Kinnegad, Kibeggan, Fore, &c. see their respective articles in this work. Westmeath has three representatives in the imperial parliament, two for the county, and one for the borough of Athlone.—Beaufort, Young, Collected, &c.

WESTMINSTER, a spacious, populous, and important city of the county of Middlesex, England, is situated on the north bank of the river Thames, and constitutes the western extremity of the metropolis. Although in every respect, local position alone excepted, independent of London, Westminster constitutes a most essential portion of the great metropolis of the British empire. The line of demarcation between these two cities has long indeed, by the rapid increase of buildings, ceased to be perceptible to general observation; but it is not the less real and efficient. The inhabitants of Westminster, it is true, consider themselves, in a general sense, as belonging to London; but for the purpose of internal discrimination, they confine the term Westminster to its original signification, the site and the environs of the present collegiate, formerly the abbey-church of St. Peter. Considering the city in this restricted

sense, and St. Peter's church as the centre, the latitude of Westminster is $51^{\circ} 29' 52''$ N., and the longitude $0^{\circ} 7' 32''$ W., from the meridian of the royal observatory in Greenwich-park. St. Peter's church bears from St. Paul's in London W.S.W. 2900 yards, or above one mile and five furlongs. The form of Westminster, in its present extended state, is triangular, having the base along the line of Oxford-street, which separates it from Marybourne on the north; and the vertex on the Thames, where the buildings terminate at Millbank on the south. The base, from Tyburn turnpike, at the western extremity of Oxford-street, to the vicinity of Chancery-lane, at Lincoln's-inn, measures nearly two miles. The side on the west from that turnpike to the vertex on Millbank, is also about two miles. The remaining side on the east, in a right line from the vertex to Chancery-lane, is one mile and six furlongs. The ground occupied by the buildings of the city and liberties therefore contains one square mile and a half, or about one thousand acres. Westminster and London come into contact at Temple-bar, the boundary of the former city commencing at the Thames on the west of the Temple-buildings, and running north to Lincoln's-inn. There quitting London, it turns westward to the eastern extremity of Oxford-street, excluding the church and parish of St. Giles-in-the-Fields, which belong to the county of Middlesex.

General View of Westminster.—From the extent of ground occupied by the city and liberties, and from the general population, amounting, by the enumeration of 1811, to 162,085 persons, Westminster would, in another position, be fully entitled to rank high among the secondary capitals of Europe. In common language, the great aggregate of Westminster is termed a city; but that term belongs only in strictness to the immediate environs of St. Peter's church, while all the other parts of the community are spread over the district or liberties belonging to the monastic establishment, of which that church was a principal member. The city is of great antiquity, in the sense in which antiquity is estimated in Britain; but the occupation of the liberties is of comparatively late date. This portion of Westminster may also be distinguished, as to its age, into the old and the new towns, by a line running north from Charing-cross up St. Martin's-lane into Crown-street, Soho-square, and terminating near St. Giles's church, at the eastern end of Oxford-street. On the east of this line lies the old town, and on the west spreads out the new. The distribution of the streets, and the construction of the buildings of the city, sufficiently indicate their early origin; an observation not unsuitable to the extremities of the old town. The new town, on the other hand, having been formed when better notions of distribution and arrangement began to prevail, possesses a high proportion of all the advantages which such notions were calculated to produce. The abbey-church of St. Peter is distant from the limits of London at Temple-bar, by the present streets along the Strand and Whitehall, about 2400 yards, or one mile and three furlongs; but from Temple-bar to the extremity of the Strand, at Charing-cross, is only 1500 yards, or seven furlongs. The origin of this street is manifest from its name, having been only a road along the strand, or bank of the Thames, leading through the village of Charing to Westminster. Without keeping however precisely along the margin of the water, the road, owing to the steep fall of the bank, was carried forward at such a distance as to permit spacious houses and gardens to be formed on the slope between it and the river. The residence of the court, in early times, was frequently in the Tower of London, or at some place at a distance from the capital; but under Henry III., who

reigned from 1216 to 1272, the court usually resided in Westminster. The courts of justice, which had before accompanied the king in his motions, were, by his confirmation of *Magna Charta* in 1225, made stationary in Westminster, where the parliament also generally met. For the convenience of attendance on the king, the courts of justice, and the parliament, for the enjoyment also of good open air, and an agreeable prospect, many of the nobles, and especially of the bishops, erected palaces along the banks of the river. Persons of inferior station, whose chief dependence for business and subsistence rested on those great men, were necessarily induced to fix their abode in their vicinity. In this way, a chain of dwellings, of various sorts, was progressively raised between the cities of London and Westminster, and united both with the intervening village of Charing. The situations of those palaces, or inns, as they were called, are preserved to the present day, in the succession of streets retaining their names, which communicate from the Strand on both sides, especially to the river. Thus, for instance, from Temple-bar we come to streets bearing the names of Essex, Arundel, Norfolk, Surry, Somerset, Savoy, Beaufort, Cecil, Salisbury, Durham, York, &c., all calling up personages memorable in former times; but of the houses to which those names belonged, no vestige, if we except the fragments of the palace of the Savoy, and the present Northumberland-house, can now be said to remain. The opposite side of the Strand being cut off from the use and the view of the Thames, was of course little frequented; but Exeter-change still indicates the residence of the celebrated Cecil, lord Burleigh, whose son Thomas became earl of Exeter. Bedford and Southampton streets declare the origin of their names. As late as in the year 1353, when Edward III. was on the throne, the Strand was an open highway, crossed and cut up by water-courses from the higher grounds. It was then repaired, but not before great complaints had been made: for in the petition of the persons who lived near the palace of Westminster to Edward II., "the footway from Temple-bar to the palace" is stated to be so bad, that "the feet of horses, and rich and poor men, received constant damage, especially in the rainy season; the footway being interrupted by thickets and bushes." From Temple-bar to the palace of Savoy, the Strand seems to have been paved, or properly made about 1385, in the reign of Richard II.: but the paving went no further till the latter part of Elizabeth's reign; and in the 35th of Henry VIII. the road was stated to be "full of pits and sloughs, very perilous and noisome." In the year 1533 the Strand took the form of a street, bordered on each side with houses and gardens; among which was Covent-garden, corruptedly so called from the garden of the convent, or abbey of Westminster, to which it belonged. Charing was still a detached village; St. Martin's church stood literally in the fields; and St. Giles's, also situated in the fields, stood in a distant hamlet in the country. Such, however, was the increase of the town in the end of Elizabeth's reign, that in 1600 St. Martin's-lane was built on both sides; and although St. Giles's church still stood detached, the great west road, now called Holborn, (properly Old-bourne, from the name of a small brook running along it,) was formed into a street all the way into London at Fleet-ditch. Covent-garden and Lincoln's-inn-fields were partially built on, as were Drury-lane and Long-acre, and principally inhabited by the gentry. The village of Charing was long before this time, or in 1292, adorned with a cross by Edward I., being the last spot where the body of his queen rested on the way to Westminster. In 1647 it was removed, and in part employed in pavement at Whitehall;

but soon after the Restoration, its place was filled, as it now is, by a statue of Charles I. on horseback. From Charing to Westminster, the bank of the Thames was occupied by the residences of royal, or other distinguished personages. First was a palace for the king of Scotland, when he came to court to attend the parliament, of which, on account of lands he held in England, he was considered a member. An ancient painting, formerly in the college of arms in London, represented Edward I. sitting in parliament, having on his right-hand Alexander III., king of Scotland; and on his left, Llewellyn, prince of Wales. The palace has long been effaced, but its site is still called Scotland-yard. To this succeeded in position the palace of Whitehall, which will be noticed in another place. The church of St. Martin stands within the limits of the old quarter, but its parish originally extended over the whole of the new quarter of Westminster; and out of it, as buildings increased, the parishes of St. Paul, Covent-garden, St. James, St. Anne, and St. George, have successively been formed.

Among the various improvements lately introduced into the streets of Westminster, must be reckoned the substitution of gas-lights for oil-lamps, now much in use in shops as well as without doors. The gas, or vapour, is extracted, by a species of distillation, from pit-coal. Purified from the incombustible aerial substances with which it is extricated from the coal, by transmission through a body of water, the inflammable or carburetted hydrogen gas is conveyed by pipes, like water, to the places where it is wanted. By the admission of flame to the orifice of the pipe, the gas takes fire, producing together with a strong heat, a lively light of peculiar force and brilliancy. The coals from which, in London and Westminster, the gas is obtained with the greatest effect, are the Lancashire cannel, and the Scotch splint coals. Newcastle coal is found to be much less pure, but from its cheapness is now mostly used.

Origin and History of Westminster.—Much learning and more fancy have been employed in devising an etymology for the name of London; but the name of Westminster is too obvious to afford exercise for the skill or the ingenuity of the philologist or the antiquary. The Saxon terms composing the latter name evidently refer to the church of St. Paul, in London, in the east. Stowe indeed, and some later writers, carry the reference to a monastery, not far from the Tower of London, called the East-minster. But that establishment was founded only by Edward III., in the middle of the fourteenth century, long posterior to that of Westminster, and could not therefore have given origin to the latter institution. The history of Westminster is founded on, and closely interwoven with that of the monastery of St. Peter: for to the existence and importance of the latter, the rise, progress, and prosperity of the former must be attributed.

The site of the church and monastery of St. Peter was in early times an island, inclosed by the main channel of the Thames on the east, and by a collateral branch of that river on the west. History furnishes no information concerning the limits or the extent of this insulated tract; but by a careful examination of the ground, even under all its alterations, the course of the collateral branch may still be discovered. This branch seems to have broken off from the Thames to the east of Chelsea hospital, to have passed northward, along the natural hollow in which the water still flows to supply Chelsea water-works, and thence over a short interval, now covered with the houses of Pimlico, into the depression occupied by the canal in St. James's park, across the site of Whitehall into the Thames. In this case the island was in length from S.W.

WESTMINSTER.

to N.E. about one mile and three-quarters, and in breadth in the middle about half that distance. Of this spacious tract, by far the greatest portion must, in former times, have been regularly overflowed by each returning tide of the river; as it would be at the present time, were not the embankments bordering the Thames carefully preserved. The age of these mounds is unknown; but to no others than the heads of the monastery to whom the island belonged can their formation be reasonably ascribed; and to them is Westminster therefore indebted for the many advantages derived from the lands rescued from inundation. The embankments must have been constructed, and the ground within them well improved in 1386: for in that year abbot Litlington died in the manor-house of *Neyte*, situated within that space. So desirable was that situation, that the duke of Lancaster, styling himself king of Castille, had requested leave to reside in the house during the sitting of a parliament. The name of this place still survives, although absurdly corrupted into *Neat-houses*. In an authentic charter, dated in 785, Offa, king of Mercia, grants certain lands to the monastery of St. Peter: its situation is described to be in "Tornea in loco terribili ad Westmunster." In the writings of Sulcardus, a monk of this monastery who wrote in the eleventh century, the name is Thorneia. Both these names are supposed to be formed from the Saxon *Thorn-ey*, the isle of thorns and briars, expressing the wild uncultivated state of the "terrible spot" noticed by Offa. Forbidding as such a situation now would be, it bore a different aspect in ancient times; for it possessed alike security from attack, and seclusion from the world. To the religious establishment on Thorney, the rise, progress, and prosperity of Westminster are to be ascribed; but the origin and the date of that establishment itself are involved in obscurity. The probability, however, is, that it was founded by Sebert, king of the East Saxons, who died in 616. That it had in 785 acquired celebrity, is evident from the charter before-mentioned, granted by Offa. From Sebert's time the monastery seems to have been only a priory; but by Offa it was changed to an abbey, of which the abbots arose, in the course of a few years, to the highest dignity of which their rank was susceptible. To demonstrate more fully his attachment to the patron of the abbey, St. Peter, Offa in it deposited his coronation-robcs and regalia. From this circumstance, perhaps, as much as from subsequent papal authority, St. Peter's church afterwards became, and still is used for the inauguration of the English sovereigns; and to the dean, as successor of the abbot, are intrusted many of the implements and ornaments employed in that important function, which was first there performed on William the Conqueror, in 1066. After suffering severely in common with other works of the same character, by the ravages of the Danes, the abbey was restored by Edgar, who began to reign in 957, on the instigation of Dunstan, who removed thither, probably from Glastonbury, twelve monks of the order of St. Benedict. It is nevertheless to Edward the Confessor that the institution is principally indebted for its splendour. Sulcardus informs us that Edward had vowed to go to Rome, there to express his pious gratitude to heaven for his unexpected establishment on the English throne. The many inconveniences, however, by which the performance of this engagement must have been attended, induced him to substitute in its stead some other mode of testifying his thankfulness. He therefore undertook to rebuild the church and monastery of St. Peter in a magnificent manner, and endow them with ample revenues. Of the structure itself we only know from Matthew Paris, that "it was constructed in a new kind of arrangement, from which many persons in erecting churches

took a pattern, and strove to imitate it." Speaking of the same edifice, sir Christopher Wren refers to an account printed from an ancient manuscript. This account he translates into language proper for builders, in this way. "The principal area or nave of the church being raised high, and vaulted with square and uniform ribs, is turned circular to the east. This on each side is strongly fortified with a double vaulting of the aisles in two stories, with their pillars and arches. The cross-building, contrived to contain the choir in the middle, and the better to support the lofty tower, rose with a plainer and lower vaulting; which tower then spreading with artificial winding-stairs, was continued with plain walls to its timber-roof, which was well covered with lead." The striking novelty in this structure was probably the introduction of an imitation of a cross in the plan: for the earlier Saxon churches are supposed to have had no transepts. The grants of lands, and of relics, bestowed by Edward on his new foundation, were ample beyond all precedent. He likewise invested it with peculiar privileges, exempting it from all secular services and authority, even from episcopal superintendance. But this last exemption brought on each new abbot the trouble and expence of a journey to Rome, to be confirmed by his holiness in person. Edward died on the 5th of January, 1066, having survived but a few days the splendid ceremony of the consecration of the new structure. From these privileges, afterwards extended to a considerable space connected with the abbey, may be traced in a great measure the present civil constitution of Westminster. While Laurence was abbot in 1163, in the reign of Henry II., the power was obtained from pope Alexander III. for his using the mitre, ring, and gloves, distinguishing marks of episcopal dignity. But this privilege became, in the sequel, of still higher importance; for mitred abbots came to sit in parliament as well as bishops, and to enjoy every honour to which bishops, as lords of parliament, were entitled. Laurence dying before the papal approbation of the measure was formally announced, his successor Walter was the first abbot of Westminster who actually enjoyed the honours of the mitre. The reign of Henry III., of great importance in the history of England in general, is not less so to that of Westminster abbey in particular. In it the greater part of the edifice was rebuilt, in the lofty elegant style by which it is chiefly characterized; a style which about that time began to be adopted in ecclesiastical buildings throughout Europe. As early as 1220, although then only a youth, Henry laid the first stone of the chapel of the Virgin, which was afterwards superadded by the gorgeous structure of Henry VII.; but it was not until 1245 that he directed the church to be enlarged, and the tower, with the eastern part, to be constructed anew. In 1269 the building was opened for divine service, and the body of Edward the Confessor was deposited in a splendid shrine erected behind the high altar.

The abbey of Westminster is entitled to the peculiar veneration of every friend of literature, of science, and of civil and religious liberty; for within its bounds was erected the first apparatus for printing books employed in this island. William Caxton, a mercer of London, during a long residence on the continent as agent for the affairs of his company, and in 1464 as minister from Edward IV. to the duke of Burgundy, became acquainted with the art of printing, then very recently practised in Lower Germany. In 1471 he printed at Cologne a work which he had translated from the French into English; and returning home in the following year, he, under the patronage of the abbot of Westminster, commenced printing in the almonry, or eleemosynary adjoining to the abbey. In March 1474 appeared his book

on the "Game at Chefs," which may be regarded as the first production of the English press. (See PRINTING.) The honour of being the first protector of printing in England has been frequently assigned to John Islip: but this must be erroneous; for he became a monk only in 1480, and arose to be abbot only in 1500. To one of his predecessors, therefore, to Estency, elected in 1474, or rather to Millyng, elected in 1469, is the introduction of printing to be attributed. The abbacy of Islip is however memorable on another account. In it was founded, on the 24th of January, 1502-3, the celebrated chapel of Henry VII. Having obtained the crown as heir to Henry VI., he resolved to erect a sumptuous monument for his remains, in the expectation of his canonization. The first part of the project was carried into effect: but the court of Rome requiring a greater sum for compliance with his solicitation than the prudent Henry of Richmond cared to bestow, the last part of the project was relinquished. Westminster-abbey was now on the eve of great alterations. The schemes of Henry VIII. began to be put in practice. On the 16th of January, 1539-40 a surrender of the whole establishment was executed by abbot Benson of Boston, and twenty-four of the monks. The annual revenue is stated to have then been nearly 4000*l.*; a sum of great real value, when the pound of beef was regulated at one halfpenny, and that of veal and mutton at three farthings.

Prior to the dissolution of the monasteries, Henry had resolved to convert some of them into episcopal sees, to be endowed with a portion of the lands or the revenues which that dissolution would place at his disposal. Of the projected sees, Westminster was to be one; and on the 17th of December, 1540, the abbey-church was, by letters patent, constituted a cathedral, with a bishop, a dean, twelve prebendaries, and other inferior officers. The new bishop was Thomas Thirleby, then dean of the chapel-royal. The late abbot Benson was, for his ready compliance with Henry's wishes in the change of the abbey, appointed dean of the new cathedral: certain monks became prebendaries, minor canons, and students in the university: the others were dismissed with pensions, decreasing from ten pounds down to five marks. The abbatial mansion was converted into a palace for the bishop, whose annual revenue is variously stated from six hundred to eight hundred pounds. The diocese included the whole county of Middlesex, with the exception of Fulham, the rural residence of the bishops of London. The endowment of the dean and chapter was not completed till the 5th of August 1542, when lands, in various parts of the kingdom, were assigned, of the yearly value of 2598*l.*, out of which, however, the sum of 400*l.* was to be paid for the salaries of five professors of divinity, law, physic, Hebrew, and Greek, in each of the universities. A farther sum of 166*l.* 13*s.* 4*d.* was to support 20 students in the universities; and two masters, with 40 grammar scholars, were to be maintained in the school of Westminster. The new bishopric was, however, but of short duration; for on the 29th of March 1550, bishop Thirleby was required to surrender it to Edward VI., and it was soon afterwards reunited to that of London. Part of the possessions of St. Peter's cathedral were appropriated to the repairs of St. Paul's in London; whence arose the proverb of "robbing Peter to pay Paul." In the edict for suppressing the see of Westminster, no mention was made of the establishment of a dean and prebendaries, &c.; it became consequently a question whether they were to be continued. To remove all doubt on this head, an act passed in parliament, declaring the church still to remain a cathedral, with the former establishment, but within the diocese of

London. On the accession of Mary to the throne, the restoration of the monastery to its pristine condition was carried into effect. The abbot, John Fackenham, surviving Mary, was the only ecclesiastic of his rank who sat in the first parliament of Elizabeth in 1558; and he took the lowest place on the bishops' bench. But on the 21st of May 1560, the monks were again displaced, and the church again rendered collegiate, on a basis very similar to that which had been established by her father, Henry VIII. The last dean of Elizabeth's appointment was the learned Lancelot Andrews, afterwards bishop of Winchester, dean of the chapel-royal, and a special favourite of James I. Since the restoration by Elizabeth, if we exclude the general disorganization of similar institutions, in consequence of the internal disorders which commenced in the reign of Charles I., the collegiate establishment of the abbey-church of Westminster has undergone no material alteration.

Abbey-Church.—Such is briefly the history of the religious establishment on Thorney, to which modern Westminster is indebted for its origin and prosperity. Of this establishment, the church remains in a great measure entire: the buildings appropriated for the abbot and the monks have undergone great alterations; but their general arrangement may still be traced, and they are still allotted for the residence of the persons attached to the service of the church and the dependent school. For a fully detailed description of this celebrated church, of its architectural beauties and defects, of the sepulchral monuments it contains, of the ceremonies performed within its walls, and for a recapitulation of the important transactions connected with its history, recourse must be had to the various works published specially on the subject. This church is a distinguished specimen of that mode of architecture, commonly but absurdly styled Gothic, a term which, however improper, most writers still continue to employ, though no specific style or class of building is defined by it. Erected in the 13th century, when buildings in this style of architecture were well understood, and skilfully constructed, it would doubtless have possessed, if not the spaciousness, at least the light and airy and elegant appearance for which such structures are generally remarkable. But by the introduction of sepulchral monuments, elevated above the level of the choir, many of them magnificent indeed in themselves, but certainly misplaced as far as regards the internal arrangement of the building, that attractive appearance must very early, perhaps from the beginning, have been injured. Owing to those encroachments, it has been necessary to bring forward the present choir much beyond its usual station, not only intercepting the transepts, but advancing a considerable way into the nave, or body of the church. The building consists of a nave and two side aisles, separated by ranges of tall, slender, clustered columns, supporting the roof raised to a great elevation, still further increased in appearance by the narrowness of the space between the columns. The length of the whole edifice within the walls is 360 feet, the breadth of the nave and aisles 72 feet, the length of the cross or transept 195. The insertion of St. Edward's chapel in the choir is particularly unfavourable; for that important division of the building was from the beginning very short: nor is it easy to discover the reason of this deviation from general usage. On entering the great western door, the whole body of the church displays itself to view in a very striking manner. Loftiness, lightness, and elegance, are its marking features; but these features are much obscured, and distracted by the numerous discordant monuments, which fill up the open spaces, and cover the walls. The nave is separated from the choir by a screen; and east of the latter is a chapel,
raised

raised above the level of the pavement, appropriated to the shrine of Edward the Confessor, but also occupied by several monuments to royal and noble persons. At the east end of this is a sumptuous architectural chantry to the memory of Henry V. Still more to the east is the splendid and interesting chapel, called Henry the Seventh's, because begun by him, and founded for his mausoleum. On the north and south sides of the choir are aisles, and also some small chapels, dedicated to different saints.

From the time of Henry VII. little was done, although very requisite, to the exterior of Westminster church, till that of George II., when many parts of it were coated over with stone, and otherwise repaired at the public expence. Some time before this, the two towers at the west end were completed from designs of Sir Christopher Wren, as they now appear. In covering the outside of the church, the rich sculpture, and the statues which formerly adorned the buttresses, could not be restored. Those parts seem now, therefore, unsuited to the highly ornamented building to which they are attached: nor do the western towers assimilate with the style of the fabric to which they belong. The paintings in the great west window were executed in 1735: the window in the south transept was also renewed in 1705. In the interior of the church, the pillars dividing the nave from the side aisles guide the eye to the fine painted window at the extremity of the choir, which, in former times, when the altar-piece was low, must have had a fine effect in giving a lighter air to that part of the building. The altar-piece was brought hither by queen Anne in 1706: it had formerly belonged to Whitehall chapel. The marble columns of the Corinthian order, however elegant in themselves, but ill accord with the style of the structure around them; an incongruity but too often sanctioned in other edifices of the same kind in England. In front of the communion-table is still to be seen, although woefully mutilated, a curious Mosaic pavement of lapis lazuli, porphyry, jasper, serpentine, touch-stone, &c. placed there by abbot Ware in 1272, who brought it from the continent, where he procured the materials during a mission to Rome. The black and white lozenged marble pavement of the choir, was the gift of the celebrated Dr. Busby, master of the school annexed to the church. In the centre of Edward the Confessor's chapel, stands the mutilated body of the shrine, containing, in a wooden case, the ashes of St. Edward; and around the sides of the chapel are ranged the monuments of several kings, queens, and princesses, from Henry III. to Elizabeth, the daughter of Henry VII.; all of which are extremely curious and interesting. In this chapel are preserved the chairs, one very ancient, the other made for the last queen Mary, in which our kings and queens are seated within the choir at their coronation. In the frame of that used by the king is the fatal stone, to the position of which the sovereignty of Scotland, or rather of the Scotch nation, was attached.

The choir of the church, in the form of a semi-octagon, was surrounded by eight chapels, now reduced to seven, by the appropriation of the central chapel to be the porch of that of Henry VII.

The cross-aisles or transepts of the church, as well as the nave, have long been consecrated to the interment of persons in various ways distinguished in the world. The south transept has only an eastern aisle, the west being occupied by part of the cloisters. This transept, named Poets'-corner, contains many interesting memorials of men whose genius and talents in science, literature, and the arts, entitle them to the honourable recollection of posterity. Of these monuments, many are highly interesting as memorials of

eminent characters, and others as specimens of the sculptor's art. No small number of them, however, and those not the least sumptuous and obtrusive, are entitled to no regard on either account, being vast masses of marble devoid of beauty and taste. It is, however, to be remembered, that to be "numbered among the illustrious dead," within the walls of the abbey-church of Westminster, now is and long has been purely a question of finance with the officers attached to the foundation.

Chapel of Henry VII.—In ancient cathedrals and other churches of considerable extent, it was the practice to appropriate to the peculiar service of the Virgin, the chapel situated immediately behind the high altar, and in the eastern recess of the building. Such a chapel originally belonged to the abbey-church; and on its site with some adjoining space, under the same patronage, but now best known by his own name, Henry VII. constructed his magnificent and admirable chapel. When we contemplate this most curious specimen of English architecture, and consider the expence which must have been encountered to complete it, we are utterly unable, on any rational grounds, to reconcile its erection with the acknowledged disposition and character of the founder. In perusing the history of nations, we must be struck with the frequent recurrence of this fact, that men of all degrees, particularly of the highest, have acted on the vain supposition, that, by a single ostentatious act of beneficence or munificence, not unfrequently posthumous, they could acquire immortal fame, and even secure the favour of heaven, however unworthily they may have performed their duty in life. Of this fact, the chapel of Henry VII. stands a memorable example; for in no one act of his life and reign, did that prince give evidence of any one of those feelings from which the construction of this superb structure could be expected to proceed. Of benevolence, however, in a certain sense, no sovereign ever had a better conception than Henry. The vast sums he exacted under this specious title, far exceeded the demands for which they were required: he accordingly amassed great wealth, and at his death his treasury was enormously rich. Towards his end, Henry, sensible of a mis-spent reign, endeavoured to atone for his offences by various charitable works, by bestowing a large sum on King's-college chapel in Cambridge, and in particular by founding, erecting, and endowing his chapel in Westminster. From the elegance and richness of the design, and from the skill and labour necessary to complete it, we are warranted to conclude that the most eminent artists and artificers of the country were employed. The first stone of the new chapel was laid by the hands of abbot John Islip, and other persons of the court, in the presence of Henry, on the 24th of January 1502-3. How much of the work was executed at the king's death, on the 21st of April 1509, is unknown; but most probably the masonry must have been nearly, if not altogether, completed. Towards the finishing of the whole, Henry left, in the hands of the abbot, 5000*l.* with provision for more if required. The superb tomb for the king is particularly described in his will; but a different plan was followed, and the work was finished by his son Henry VIII. The ground-plan of the building consists of a body nearly a square, terminated at the east end by a semicircular part, composed of five sides of an octagon. The extreme length of the whole chapel, including the porch, is 134 feet, and the corresponding breadth 82 feet 6 inches. On viewing the exterior of the building, we are struck by the apparent slightness of the work; for instead of walls, the principal weight and quantity of the whole rests on a few detached piers and lateral buttresses. This peculiar character of
ancient

ancient ecclesiastical buildings, manifests great science and skill in the architects; for to raise lofty walls, and poise ponderous wide-spreading roofs on piers and columns, requires the nicest geometrical accuracy. The sides are supported by five octagonal piers; those of the semicircular end are united to wedge-shaped masses, entering so far into the chapel, as to correspond with the pillars separating the aisles from the nave. The interstices between the external piers are filled by windows of a peculiar plan and great delicacy of workmanship. The roof over the nave rests on perpendicular walls, supported by very slender internal pillars, and is strengthened all around by flying buttresses or semi-arches from the external piers. Within, the chapel is divided by two ranges of pillars into a nave 33 feet 6 inches in width, and side-aisles each 11 feet 3 inches wide. The internal roof is executed in stone, with pendants and numerous ribs. By the advance of the piers in the circular part, that end is formed into five small chapels or oratories; but the side-aisles in their original had no separation from the nave, except the ranges of pillars. They are now, however, unfortunately cut off by a row of stalls on each side, on the line of the pillars, and shooting up with their fretted and frittered canopies as high as the roof of the aisles. What tends to heighten the deformity of these stalls, is the number of gaudy flags of the knights of the Bath, who are installed in this chapel, suspended all around, at once concealing many beautiful parts of the architecture and sculpture, and utterly at variance with the elegance and the design of the edifice. The entrance to the chapel is by a flight of steps to a magnificent gateway, but from its situation dark in itself, and darkening the extremity of the adjoining church. The chief object within the chapel is the tomb of the founder, inclosed by a screen of gilt brass: it is a piece of admirable workmanship, executed by Torregiano of Florence, a rival of Michael Angelo. There also, still in opposition, lie the jealous and vindictive Elizabeth and her unfortunate victim Mary Stuart. Thus in a corner of the abbey-church, a few feet only of earth now separate the once formidable political antagonists William Pitt and Charles James Fox. The bronze figure of Margaret Tudor, mother of Henry VII., is one of the finest pieces of sculpture in the whole building. In viewing this chapel, two subjects always excite regret; the situation in which it stands, and the materials of which the exterior is constructed. Attached to the end of the abbey-church, with which its mode of construction has but a very distant relation; although in itself, if furnished with a suitable front-piece, worthy to be a separate and independent work, it now sinks into a mere appendage. The exterior surface of the chapel is in many parts corroded and consumed; and most of the sculpture is now quite defaced. Some years ago parliament voted a considerable sum of money, to be annually applied to defray the expence of new-casing the whole edifice with Bath stone, and the work has been carried on under the directions of Mr. T. Gayfere, with scrupulous attention to the form and manner of the original workmanship. Beneath the chapel is the vault prepared on the death of Caroline, queen of George II. in 1737, and containing the remains of several members of the present royal family. The cloister of the abbey, still sufficiently entire, and containing numerous sepulchral inscriptions, communicates with the ancient chapter-house, which is of octagonal form, and the roof is supported by a branching central column. It was erected, according to Matthew of Westminster, in 1250, by Henry III. This building, which, till the time of Edward VI., served as a house for the commons of England, is now employed to preserve public

records; amongst them, the celebrated *Liber de Wintonia*, as it was called by the compilers, or *Domesday-book*, as it was not unaptly named by those persons whom it regarded. This work, the most ancient and venerable record, or statistical account, as we now speak, of which this or any other country can boast, was completed about 1086, in the end of the reign of William the Conqueror. (See *DOMESDAY-BOOK*.) In the same chapter-house are also preserved the recorded proceedings of the notorious star-chamber, so called from the star-like ornaments of the roof.

School.—The cloister also communicates with the celebrated school of Westminster, which was refounded by Elizabeth in 1590, with an establishment for the classical instruction of forty boys. After a certain time, the scholars, if duly qualified, are selected alternately for their respective institutions, by the dean of Christ-church, Oxford, and the master of Trinity college, Cambridge. Besides the youths on the foundation, from three to four hundred, others usually receive their education in the school, at the expence of their respective parents.

Parish Churches of Westminster.—The city and liberties are now distributed into ten parishes. Within the city are St. Margaret's and St. John the evangelist's; within the liberties, St. Martin's, St. James's, St. George's, St. Anne's, St. Paul's, St. Clement's, St. Mary's, and the Savoy. St. Margaret's, the original church of the city, is a simple plain structure. It is handsomely fitted up to accommodate the commons of the kingdom on certain solemn occasions; as the choir of the neighbouring abbey-church is allotted to the peers of parliament. One peculiar ornament of St. Margaret's church is a magnificent painted window representing the crucifixion. This very interesting piece was executed in Holland as a present for Henry VII. St. John's church, belonging to a parish formed out of St. Margaret's, furnishes an admirable example of what imagination, unrestrained by judgment and taste, can produce. It ought however to be known, that Mr. Archer, and not sir John Vanburgh, who has been oftener blamed than understood, was the architect of this fabric. St. Martin's and St. George's churches are remarkable for their noble porticoes; but both are so unfortunately, not to say absurdly situated, that it is impossible to have a view of them in any way satisfactory. St. Paul's, Covent-garden, is noted for its simplicity, and its plain, heavy, Tuscan portico. In erecting the latter at the *east* end of the church, where it can be seen, Inigo Jones essayed a bold deviation from established practice; but to change the interior distribution of parts was perhaps beyond his power. The portico therefore stands where no entrance can be opened, for there within stands the communion-table; and the entrance is opened at the *west* end, where there should be, but is not, a portico. The church of St. Mary, like that of St. Clement, is strangely placed in the midst of the Strand, a most public and noisy street; and instead of possessing the simple dignity of a Christian temple, seems rather a model contrived to shew the skill of the architect in comprising the greatest quantity of ornament devoid of utility, within the narrowest bounds. But Mr. Gibbs the architect followed his instructions in adorning an edifice to be so ostentatiously exhibited. He had besides but just returned from Italy, where similar structures abound. It is no wonder, therefore, that, in both the interior and the exterior of the New church of St. Mary, he was led to imitate the buildings he might, as a mere student of architectural design, long have admired.

Besides the churches and chapels of the establishment, Westminster contains places of worship for Christians of all denominations, and of professions the most contradictory, from the mysterious Swedenborgian, who maintains the sole

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and absolute *divinity*, to the simple Unitarian, who asserts the pure *humanity* of the great founder of the Christian religion. French, Swiss, Dutch, and German Protestants, have proper places where the service is performed in their own languages. The Society of Friends or Quakers have a respectable place of assembly in St. Martin's-lane; and various chapels are open for the members of the church of Rome. In Denmark-court, in the Strand, is a well-frequented Jewish synagogue.

Civil and Political State of Westminster.—The first dwellings constructed around the monastery in Thorney, stood on the lands of the establishment, which consequently had full authority to govern the inhabitants. These were rapidly increased in numbers by the privilege of sanctuary granted to the abbey for offenders; but the great causes of the growth, population, and importance of Westminster, were the residence there of the kings, and the transaction of all public business within its precincts. Although the Strand, Whitehall, and a few other parts were inhabited, at the elevation of the abbacy into an episcopal see in 1540, yet the quarter only immediately inclosing the cathedral church was honoured with the title of city. The whole of this quarter was included in the original and ancient parish of St. Margaret; but in order to accommodate the increased body of inhabitants, especially in the southern parts, a new parish was formed out of the old in 1728, and named after St. John the evangelist. All the other quarters of the present Westminster, erected on the liberties of the abbey, are contained within the following eight parishes, arranged in the order of their establishment. St. Clement's Danes, St. Martin's in the Fields, and St. Mary's in the Strand, all of uncertain antiquity. St. John the Baptist's, in the Savoy, also ancient, St. Paul's, Covent-garden, St. James's, St. Anne's, Soho, and St. George's, Hanover-square; the last four all formed within the last 200 years. In designating Westminster in the aggregate, the city and the liberties are necessarily mentioned; but in no respect does any distinctive rank, right, or privilege exist between the inhabitants of those different quarters, who are all equally citizens and members of the same community. On the public change of religion, and the conversion of the abbey of St. Peter into a collegiate establishment of a dean and chapter in 1560, the latter were placed, as to all their civil rights and authority, in the situation possessed by their predecessors; but the sanctuary was, with all other similar privileges, suppressed in the 21st year of James I. The dean and chapter of St. Peter's have, therefore, continued ever since to be the supreme magistrates and administrators of the inhabitants of the city and liberties of Westminster. Since the Reformation, however, the exercise of all civil powers has always been vested in lay persons, elected or confirmed by the dean and chapter. Of this singular and anomalous system of government, which, how applicable soever to the original, seems wholly unsuitable to the modern Westminster, the following are the principal members, as settled by an act of the year 1585:—The first is the high-steward, usually a resident nobleman of distinction (the present is the duke of Northumberland), who is elected by the chapter of St. Peter's; the dean acting as high-steward during and previously to the election. By this principal officer a deputy steward is nominated; but his appointment must be confirmed by the dean and chapter. This deputy acts as a sheriff, holding the court-leet with the other magistrates: he is always chairman of the quarter-sessions of Westminster, which are independent of those of Middlesex. Next in rank is the high-bailiff, nominated on the other hand by the dean and chapter, but confirmed

by the high-steward. He is the returning officer in the election of the representatives in parliament for the city and liberties; and to him all the other bailiffs are subordinate. He summons juries, and has a right to all fines, forfeitures, and strays, within his jurisdiction: he also, on due requisition, calls together and is present in assemblies of the electors, for the purpose of petitioning parliament or the crown, or of transacting any other public business in which they are all concerned. The high-constable, chosen at a court-leet of the magistrates, has all the other constables under his superintendance. In addition to these officers, sixteen householders, styled burgeses, are chosen, with their assistants out of the different parishes. These resemble the aldermen and common-council of London, each having a particular ward or district under his inspection; and of their number two head burgeses are chosen, who, at the court-leet, sit next to the high-bailiff. The inhabitants of Westminster form no corporation, nor do they possess as such any exclusive privileges; neither do any companies of trade or profession exist within the jurisdiction. The various courts of justice belonging peculiarly to Westminster are, 1. The court of the duchy of Lancaster, a supreme court of record, held in Somerset-place, for deciding by the chancellor of the duchy all matters of law or equity concerning the estates belonging to the county-palatine of Lancaster. 2. The quarter-sessions of the peace, a court of record, held by the justices of the peace at the Guild-hall, near the abbey-church, for all trespasses, &c. committed within the city and liberties. 3. The court-leet, held by the dean, or his steward, for choosing parochial officers, preventing and removing nuisances, &c. 4. Courts of requests, or of conscience, as they are called, for deciding without appeal by commissioners, all pleas for debt under forty shillings. 5. Courts of petty-sessions, held every lawful day at the offices in Bow-street, Marlborough-street, and Queen-square, for matters of police, misdemeanor, or offence. 6. To these must be added the court of St. Martin-le-grand, in London, but belonging to Westminster. The jurisdiction of the dean and chapter of St. Peter's, widely extended as the liberties are, is not confined to their bounds. In the very heart of London, under the walls as it were of St. Paul's, is the precinct, as it is termed, of St. Martin-le-grand, an integral part of Westminster, and wholly independent of London. This precinct took its name from a collegiate church founded in 1056, dedicated to St. Martin and qualified *le-grand*, on account of the great privilege of sanctuary conferred on it. By Henry VII. it was bestowed on the abbey of St. Peter; but on the surrender to Edward VI. it was pulled down, and houses were built on the ground. Being let out to strangers not freemen of London, they claimed the privileges before enjoyed by the canons of the suppressed institution. Those claims produced many contests which were never definitively settled; and the exemption of St. Martin's precinct from the jurisdiction of London seems now to be established, rather by long-continued usage than by any regular or authoritative declaration of right. This small precinct (a term in London signifying specifically a subdivision of a ward) consists of one short street of its own name, leading north from the east end of Newgate-street to the beginning of Aldersgate-street, and a few lanes and courts on each side. In this precinct persons not freemen of London, exercise their several trades or professions without controul; the inhabitants also concur in the election of representatives for Westminster, in the same way with those who actually dwell within that city. A very material change is now (1818) in progress in St. Martin-le-grand. The chief office of the general post, domestic and foreign, situated in Lombard-street, in Lon-

don, has long ceased to be either central in position or commodious in distribution, for the prodigious business transacted in it. After many attempts, chiefly on the part of the inhabitants of the west end of the town, where many of the principal men of business reside, parliamentary sanction has at last been obtained for the erection of a new post-office, properly adapted, in situation and internal arrangement, to the purposes of the establishment. The situation selected is in St. Martin-le-grand; and the necessary preparations in removing houses and clearing the ground, have made considerable progress. The expense of this enterprise must be great; but the edifice may be rendered highly ornamental as well as useful to the metropolis. Mr. Kay is the architect. The jurisdiction of the dean and chapter of Westminster extends also over some places in Essex, on that account independent of the diocesan bishop of London, and even of the metropolitan of Canterbury; for while the Roman Catholic religion prevailed, the abbey was immediately under the pope. If the jurisdiction of the abbey thus extended over places remote from its bounds, it on the other hand comprehended within its bounds, a district exempt from its jurisdiction. This is what is commonly called "the liberties, or the duchy of Lancaster." The district comprehends all the south side of the Strand, from the Temple to Cecil-street, with nearly the same extent on the north side. The palace and district of the Savoy having been a part of the possessions of the house of Lancaster, which were separated from the crown by Henry IV., that part of the Strand belonging to the Savoy became a district or liberty of itself. It has a supreme court under the chancellor of the duchy of Lancaster, as already mentioned; and formerly no inhabitant of this district voted for the representatives of Westminster. But at the election in March 1795, those of the duchy-liberties who lived within the parishes of St. Mary in the Strand, and St. Martin's in the Fields, were admitted to give their suffrages. Until after the dissolution of the abbey, Westminster sent no representatives to parliament; being virtually represented by the abbot, who sat with the bishops in the house of peers. In the records of the last parliament of Henry VIII. no mention appears of any summons or returns relative to Westminster, Peterborough, or any other abbey-town. The first parliament of Edward VI., therefore, is that in which the members for Westminster began to take their place. The two representatives of the city and liberties are elected by the inhabitant householders, or those paying scot and lot, who are now estimated at about 17,000; the number being considerably increased by the enlargement before-mentioned in 1795. The elective franchise being thus widely diffused among all ranks of the inhabitants, and the popular favour being commonly in the inverse proportion of that of the court, one if not both of the representatives of Westminster may generally be expected to be decidedly hostile to the measures of the existing administration. So well is this understood by ministers, that, to have at least one member favourable to their views, they have frequently encouraged some distinguished naval commander to offer his services to the electors.

Having for many years been the ordinary residence of the sovereign, Westminster has of course contained the principal departments of every branch of legislative and executive administration. The parliament, originally ambulatory and attached to the person of the king, was rendered stable in Westminster on the confirmation of Magna Charta by Henry III. in 1216. Long before that period, the royal palace was erected adjoining to the abbey; and as in those early times justice was often administered by the king in person, or in his presence, the various courts of judges were of

course established in or near his residence. When the palace of Westminster ceased to be occupied by the monarch, and Henry VIII., in 1512, transported his court to Whitehall, the parliament and the judges still retained their original station; but the executive branches of administration, relative to financial and military affairs, accompanied the court. Hence we see those departments all established in what is still called Whitehall; although the king has long ceased to reside in that quarter, and that a very small portion of the old palace is either occupied by public offices, or even in existence. Hence also it is that all public acts of government are dated from Whitehall. From the prodigious multiplication and subdivision of all public affairs relative to justice, finance, and military and naval operations, the details of various branches have necessarily been carried on in other convenient quarters of the metropolis. Such are the Temple, Lincoln's-Inn, Guildhall, the Bank, the Custom-house, the Excise-office, the Tower, &c.; still it is in Westminster alone that the general arrangement of the whole is conducted.

Public Buildings.—Of the ancient residence of the kings of England in the vicinity of the abbey of Westminster, the name, the general position, and a few mutilated apartments, are all now remaining. According to a survey and plan of the whole buildings and vestiges of this palace, it extended along the bank of the Thames from north to south, and then turned westward near to the buildings of the abbey. Of the general arrangement, it is impossible to discover more than that the walls and foundations seem to have been all parallel to the corresponding walls of the present great hall, the only part still remaining in its original state. Composed of parts erected at different periods, no balance or symmetry of plan seems to have been regarded in their distribution.

Westminster Hall, memorable in itself as a building, as the scene of many important transactions, and for the uses to which it is applied, was erected by William Rufus, or William II., about 1097, as an appendage to the old palace, or a part of a new project. Having suffered much from accidental fires, as well as from the lapse of time, the hall, just three centuries after its construction, was completely restored by Richard II., who heightened the walls, altered the windows, adding a new roof, and built a stately gateway. The hall is a vast parallelogram, standing north and south, in length, within the walls, 249 feet, and in breadth 66 feet, not 74, as is generally stated. The walls, although massive and plain, are externally strengthened by buttresses. The roof, rising to a high pitch, is ingeniously and firmly constructed, not of Irish oak, as usually said, but of chestnut brought from Normandy. This room is said to be of greater magnitude without pillars than any other known. In this hall parliaments have been held; Richard II. was deposed in it in 1399, and for many ages it has been employed in the coronation-feasts of the sovereigns. In it assembled the court for the trial of Charles I., in January 1649. It is still the place of inquiry, before the house of peers, into the conduct of persons impeached by the house of commons. In the middle of the right or west side of the hall, is an opening into the court of common pleas. The south end of the hall is occupied by wooden structures, to contain on the right-hand the court of chancery, and on the left the court of king's bench; so called because the king in ancient times actually sat, as he is at present asserted, by what is styled a legal fiction, actually to sit, on the bench to administer justice. Between these two courts stairs conduct to the apartments occupied by the two houses of parliament. That employed by the peers was towards the south end of the old palace; but on account of the additional number of 32 peers entitled

bled to seats on the union with Ireland, over and above the unexampled augmentation of the peerage in the present reign, their meetings were transferred to what was the court of requests; so called because the masters of the court, in ancient times, received the requests or petitions of the people, and gave their opinions on the subjects. This room, considerably larger than the former, is also within the old palace; and is now ornamented with the celebrated tapestry, representing the discomfiture of the Spanish Armada, or fleet and army, destined for the invasion of England in 1588. At the upper end of the room is the throne, a highly enriched arm-chair; and at the lower end is an open space, termed the bar. The commons of England, when they formed a separate body from the peers, were, by an agreement with the abbot of St. Peter's, allowed to meet in the chapter-house already mentioned. But when, at the Reformation, the establishment of the collegiate chapel of St. Stephen in the old palace was suppressed, to that place their meetings were transferred by Edward VI. This chapel, originally constructed by king Stephen, was rebuilt by Edward III. in 1347. The commons, before the union with Ireland, were accommodated within the chapel; but their number being by that measure augmented from 558 to 658 members, it became necessary to enlarge the place of assembly. At the east, or upper end of the room, is the speaker's chair; before it is the table with the clerks, and at the bottom is the bar. The seats for the members rise one behind another, as in a theatre. Those on the floor, on the speaker's right-hand, are called the treasury-benches, and occupied by the members of administration: the bench in front is usually occupied by the leading members of the opposition. St. Stephen's chapel, highly adorned by Edward III., suffered greatly by its first adaptation for the commons; but much more by the late alterations. By removing the wainscot, a great part of the ancient decorations was disclosed, and a very important fact in the history of the fine arts was, for the first time, ascertained. On the 11th of August, 1800, was discovered a series of sculpture and painting, the latter exhibiting portraits, scripture-scenes, and other decorations, interesting in themselves, and peculiarly so as specimens of the state of the arts, as they existed nearly five hundred years ago. It has been usual to ascribe to John Van Eyck, of Bruges, in Flanders, the invention of painting in oil-colours, in 1410. This opinion has, however, of late years, been much invalidated; by the discovery in St. Stephen's chapel it is completely overthrown. From original records of the expences incurred in the construction and decoration of that building, it now appears that the renovation was begun in the fourth year of Edward III., or about 1329, and not in 1347, as stated by Stowe and others: that the painters had not begun in 1345, but were at work in 1350, and ceased to be mentioned in 1364: that those who painted on glass had begun in 1350, and finished in 1352: that the paintings were unquestionably in oil: and that, of seventy-six painters employed in the chapel, the whole, with the exception perhaps of two, and they not the masters, were natives of England. From these authentic documents it is therefore fully ascertained, that *pictures*, in the usual sense of the term (not *house-painting*), in *oil* were executed in Westminster palace in 1350, or sixty years before Van Eyck's supposed discovery of the art. But the same genuine records go still farther back: they prove oil to have been employed in painting pictures in the chapel before the rebuilding by Edward III.; that is, in the 20th year of Edward I., or in 1272, which was one hundred and eighteen years prior to Van Eyck. (See PAINTING.) Under the old house of

lords are the cellars which were prepared for the famous powder-plot, of the 5th of November, 1605.

Whitehall Palace.—This royal mansion occupied a considerable space on the bank of the Thames, including Privy-Garden, and extending to Scotland Yard, stretching out in breadth from the river quite across the street still called Whitehall into St. James's-park. It was originally the property of Hubert de Burgh, earl of Kent, and grand justiciary of England under Henry III. The situation was low and marshy, owing to the concurrence of the branch on the west of Thorney island with the main channel of the Thames. In 1248 the palace belonged to the archbishops of York, who possessed it until, on the fall of cardinal archbishop Wolsey, it was, in 1529, seized, with his characteristic love of justice, by the insatiable Henry VIII. Possession being obtained, many alterations were made in the building, of which a portion, commonly called the Cock-pit, adjoining to the Treasury, still exists. Falling into decay, James I. resolved to rebuild Whitehall in a suitable manner; and for such a design the spacious ground between the Thames and the park, and commanding both, offered every facility excepting that of elevation of ground, without a proper degree of which dignity is hardly attainable in architecture. Of the magnificent, although in many parts faulty, project of Inigo Jones, prepared for the intended work, one portion only was executed. This is the Banqueting-house, so called from its succeeding, in destination as in scite, to a part of the old palace appropriated to royal entertainments. The present edifice, one of the few specimens of noble and regular architecture in the metropolis, consists of two stories, on a rustic basement, ornamented with Ionic and Corinthian columns and pilasters. This edifice, containing seven windows on a floor, was only one of the angular pavilions of the intended grand structure. It is sufficiently enriched, but not overloaded with ornament; and being constructed on a scale of very large dimensions in the parts, had the whole, even with all the defects of the project, been carried into effect, no sovereign in Europe could have exhibited a place of residence to be compared with that of the king of Great Britain. Magnitude of parts was in that project held to be indispensable for grandeur of effect. The interior of the Banqueting-house has long been converted into a royal, and lately into a military chapel; adorned, as is still most incongruously imagined, with trophies of war. The ceiling is peculiarly worthy of observation, being the production of the splendid pencil of Rubens; exhibiting the allegorical history of his patron, James I. This masterly performance ought to have dissuaded the advisers of George I. from converting the room into a place of Christian worship; for "its contents are in no way akin to devotion; and the workmanship is so very extraordinary, that, in beholding it, the spectator must either possess an uncommon measure of zeal, or be utterly destitute of skill and taste, who can attend to any thing besides." From a window of the Banqueting-house the unfortunate Charles I., unfortunate in living in times when the art of managing parliaments was either unknown, or perhaps thought unworthy of a prince, passed to the scaffold erected in the public street in the front of his own palace. In a court behind the building stands one of the small number of public statues of the metropolis meriting examination. It is the work of Gubbins, and exhibits James II., indicating, as he would do in his destined situation, with an air and attitude full of expression, the spot where his father suffered. At no great distance, on the former scite of the cross in the village of Charing, is erected another fine equestrian figure of Charles himself.

St. James's Palace.—That the sovereign of the British empire was far less suitably lodged in his capital than are numbers of his subjects, has by foreigners been often remarked, and by natives been sometimes converted into a compliment to the sovereign and to the nation. But the fact is, that St. James's palace was in its origin an hospital, of part of which Henry VIII. availed himself to construct the present buildings, as an appendage to the palace of Whitehall, with which it was connected by St. James's park. Having been allotted for the residence of the princess, afterwards queen Anne, and her husband George of Denmark, St. James's has ever since continued to be occupied for court or state purposes. The buildings are neither grand nor regular: the front, overlooking the park, has alone a certain air of dignity: and the state apartments, although they contain nothing peculiarly magnificent in the furniture or the decorations, are commodious and handsome.

Connected with this palace is the park of the same name, ornamented with a long canal in the middle, and with broad walks, separated by rows of trees on the sides, the only species of improvement of which its flat situation is well susceptible. Near the centre of the canal, a wooden bridge, in the Chinese style, has been built across the water. On the north-west of St. James's-park is an open space, called the Green-park, capable, from its elevation and variety of ground, of much greater improvement: but its principal recommendation is that, being in fact a wide extended green field, it furnishes a delightful promenade in all directions, and welcome relief from the hard pavement of the streets.

Buckingham-House.—This edifice, now settled on the present queen in lieu of Somerset-house, and hence called the Queen's palace, possesses peculiar attraction, as much from its very favourable situation, as from its history. It was built by John Sheffield, duke of Buckingham, about the year 1700, and its gardens were adorned with terraces, canals, &c. The building is of brick, and most of the apartments are small. In this palace for several years were held his majesty's levees, while his health permitted his appearance. Annexed to the palace are an octagon and other apartments, containing the king's library, rich in various works of value, particularly in early editions of books. Interior views of the chief rooms, with an ample history of this edifice, &c. are given in Pyne's History of the Royal Palaces.

Carlton House, the residence for a number of years of the prince of Wales, regent of the united kingdom, as formerly of the princess dowager of Wales, his majesty's mother, occupies a situation in between Pall-Mall and St. James's park. The chief front towards the street presents the singular incongruity of a lofty and highly enriched Corinthian portico, giving entrance into a low rusticated edifice. Between the house and the street is a court-yard, bounded by a low wall, sustaining an open colonnade, with an entablature. The interior has undergone many changes, and is fitted up in the most costly and sumptuous manner. The library, conservatory, and the armoury, are very fine and splendid. The work just referred to contains several beautiful prints of the different rooms; also a particular account of the house and its contents.

The ancient palace of *Somerset-house* has now disappeared, being superseded by the magnificent structures composing Somerset-place. Of the Savoy a few portions still exist, but much changed from their original destination; and in a few years, perhaps, even the whole may be effaced.

The plan of Somerset-place, as formed by sir William Chambers, was to comprehend within one vast edifice pro-

per apartments for transacting many branches of the national business; and to this purpose, incomplete as it is, it is now applied. Besides these departments, Somerset-place contains handsome suites of rooms for the Royal and Antiquarian Societies, and for the Royal Academy of the Fine Arts. The front towards the Strand, of regular architecture, is spacious and lofty; but, on the whole, having the air, as in fact it is, of the entrance to a structure of great extent and magnificence. The front consists of nine arcades on the ground-floor, the three in the middle forming the entrance, by three colonnades supported on coupled columns. Above the basement is a range of ten Corinthian semi-columns extending over two ranges of windows. Above the three centre windows rises an attic, with statues. The whole is, however, a very great work, and cannot fail, when beheld from the river, or the new bridge adjoining, to have a powerful effect on the spectator. Situated on a rapid descent to the river, the labour and expence of raising the square to the level of the street has been prodigious; and the skill shewn in constructing the whole edifice well merits admiration.

Part of the old palace of Whitehall, as already noticed, may be traced in the building usually called the Treasury; but that part which faces the parade in the Park is comparatively modern, and constructed in a style announcing strength as well as dignity and accommodation for business. Close to this edifice stands that called the Horse-Guards, because a party of that class of troops daily do duty there. Constructed on a plan and elevation intended to recal the idea of an antique fortress, it contains the chief departments of business comprehended under the title of the War-Office. The neighbouring office of Admiralty, spacious and lofty, is greatly indebted to the screen erected by the Adams, by which the enormous portico is brought to bear apparently some degree of proportion to the building.

The theatres of Drury-lane, Covent-garden, the Hay-market, and Opera-house, have been all noticed in the description of London. See LONDON.

At no great distance from the magnificent pile of Somerset-place, and similarly situated over the Thames, stands an extensive range of buildings called the *Adelphi*. The erection of these, a vast enterprise for private individuals, is the work of the celebrated architects, Messrs. Adam. The terrace, which commands the river and surrounding buildings, and the streets and buildings, are elevated on arcades rising from the edge of the water, adapted for warehouses, and opening into roads leading up to the Strand. In the Adelphi is a handsome edifice, belonging to the Society for the Encouragement of Arts, Manufactures, and Commerce. The great hall exhibits a series of paintings, unique in modern times, by James Barry. An establishment of a peculiar character has lately begun to appear on the bank of the Thames, a short way above the extreme buildings of Westminster. This is the *Penitentiary*, designed for the punishment, employment, and reformation of offenders of secondary criminality. When, by the emancipation of the British colonies in North America, transportation of offenders to that country necessarily terminated, the plan was adopted of removing them, to contribute to the colonization of the newly-acquired territories in the Asiatic seas. The system, however, when applied to cases of limited expatriation, being highly objectionable, the scheme of the rising establishment has been approved, and its execution begun. The criminals are confined in circular buildings, so constructed that the overseers may, from a central situation, unseen, observe every room. The edifice will, when complete, form externally a hexagon,

consisting of six of these circular divisions; the whole encompassed with a wall, inclosing 18 acres of ground, and calculated to contain altogether from 1000 to 1200 prisoners. Some of them are already placed, and the beneficial effects of the institution on their general conduct has already been very perceptible. As a part of Middlesex, the proper prisons for criminals are those belonging to the county; but in Tothill-fields is a bridewell for the detention and temporary punishment of petty offenders, under the charge of the magistrates of the city and liberties. The charitable establishments of Westminster for the education and maintenance of youth and the consolation of age, for the relief of disease and accidental calamity, are much more numerous and useful than splendid. St. George's and the Middlesex hospital, (not, however, properly within the town,) the Westminster infirmary, &c. are excellent institutions, superintended by medical gentlemen of the highest professional reputation. Of the distinguished private mansions of noblemen and others, it is impossible here to do more than point out a few of the most remarkable. Among these are Northumberland-house, the only residence now remaining of our ancient nobility in the Strand; the duke of Marlborough's in Pall-Mall, erected by the nation for the great duke John; the duke of Norfolk's, St. James's square; earl Spencer's in St. James's place; Burlington-house; the duke of Devonshire's and earl of Egremont's in Piccadilly; the marquis of Lansdowne's in Berkeley-square; the earl of Chesterfield's in South Audley-street; earl Grosvenor's in Upper Grosvenor-street; the marquis of Anglesey's in Burlington-street; the marquis of Stafford's, Cleveland-house. These are some of the best, as far as the exterior is concerned; but many others might be noticed highly deserving of attention, particularly for the admirable paintings by the best masters with which they are enriched.

Bridges.—It is a remarkable fact, that, great and important as Westminster is, until the construction of the noble bridge of its own name, of 15 arches, and in total length 1223 feet, completed in 1750, it possessed no other mode of communication across the Thames than by ferries, or by the embarrassed circuit of London-bridge. The opening of Blackfriar's-bridge was certainly a great accommodation for an extended portion of the town; but still something more was wanted, in a space between those bridges of no less than 3100 yards, or one mile and three quarters, of a most populous and active metropolis. About mid-way of this interval was opened, on the 18th July, 1817, a new bridge, leading from the Strand between the Savoy and Somerset-place, called the *Strand or Waterloo* bridge: it is a structure of a novel description in this country. The idea of it is not, however, new, having been frequently suggested, particularly by Gwyn in 1766. (For a particular description of this bridge, and the dimensions of its various parts, we refer to the article *WATERLOO*.) The road-way is strictly horizontal on the level of the street in the Strand, but much above the surface of the Surrey shore, to which it descends by a long and gentle slope. Each pier, as in Blackfriar's-bridge, is externally ornamented with two Tuscan columns supporting a square projection. The bridge was opened on the anniversary of the horrible carnage of Waterloo, and from this event it has been attempted to give it a name. In this case, however, as in that of what was formerly styled Pitt's-bridge, in London, in 1760, the public, unable to discover even the most distant relation between the structures and the proposed appellations, know them only, as they must naturally do, by their situation, as Blackfriar's and the Strand bridges. This admirable work

does great honour to the engineer and architect Mr. John Rennie, and to the judgment of the managers of the enterprise; and is, all circumstances of position, form, and materials considered, without a parallel in Europe. Besides the Strand-bridge, another of a different kind has lately been constructed over the Thames, just a mile above Westminster-bridge, leading over from Tothill-fields to Vauxhall, and thence properly named *Vauxhall-bridge*. The architect, Mr. Walker, has divided the breadth of the river into nine apertures, covered by frames of cast-iron, resting on stone piers. The road is not horizontal, but forms two gently inclined planes, meeting in a very obtuse angle in the middle. The length of this light and elegant bridge is 809 feet. A third bridge, not indeed immediately connected with Westminster, but of great importance to the metropolis, is now in progress. This is the Southwark-bridge, commencing between that portion of the town and the city of London, on the line of Queen-street and King-street to Guildhall. This extraordinary structure, designed also by Mr. Rennie, consists of three grand arches of cast-iron, in segments of very large circles: the centre arch 240 feet in span, and the two others of 210 feet, each. To enable the reader to form a comparative idea of the bridges now mentioned, the following dimensions of some other remarkable bridges are subjoined. London-bridge, (see *BRIDGE*.) consists of 19 very unequal arches; Southwark-bridge (the iron part), 730 feet long, and of three arches; Blackfriar's-bridge, 995 feet long, of nine arches; Strand-bridge, 1280 feet long, of nine arches; Westminster-bridge, 1223 feet long, of 15 arches; Vauxhall-bridge, 809 feet long, of nine arches. On the continent, the most remarkable structures of this description are the celebrated horizontal bridge over the river Loire, at Tours, in the west of France, in length 1335, and consisting of 15 elliptic arches; the bridge over the Moldaw, at Prague, in Bohemia, 1700 feet long. These, however, are all far outdone by the antique bridge over the Rhone, at St. Esprit, in the south of France, consisting of a multitude of small arches, supporting a very narrow road-way, extending in all nearly to 3000 feet. This bridge has the peculiarity, that, instead of being straight, it is composed of two lines forming an obtuse angle, turned against the current, as if the better to withstand its violence.

Literary and Scientific Institutions.—These have already been noticed in the article *LONDON*, to which the reader is referred. It will always be a peculiar honour for the British nation in general, and to the metropolis in particular, that, with very few exceptions indeed, all those valuable institutions for the promotion of learning, science, and the arts, which add so much splendour to the capital, owe their origin, their maintenance, and their reputation, to the voluntary exertions, personal and pecuniary, of private individuals. The two principal exceptions in London and Westminster are the *British Museum*, and the *Academy of Painting, Sculpture, and Architecture*; but from their nature, without public aid, neither of these institutions might ever have been established. (See *MUSEUM*.) The British Museum is in regular and rapid progress, in the acquisition of stores of high importance in the departments of natural history, literature, and art, to which it is devoted. The *Elgin marbles*, or the venerable monuments of Grecian sculpture, rescued by the earl of Elgin, during his embassy at the Ottoman porte, from barbaric neglect and destruction, in their original position in Athens, are objects of attraction and importance unparalleled in Western Europe. Of the British Museum, in general, it is but justice to observe, that, in no

similar establishment, can more attention be shewn to facilitate the researches, literary or scientific persons, of all who resort to the treasures it contains.

The population of Westminster very sensibly fluctuates, according to the season of the year. From October to July, while the parliament is assembled, the courts of law are sitting, and the places of amusement are open, the town is fully inhabited. During the other months, even those whose business is still transacted in town retire to their villas or quarters, in the surrounding villages and country. A hundred years ago, the inhabitants were computed, but surely overrated, at 130,000: by the last returns to parliament in 1811, they amounted to 62,085, occupying 17,555 houses.

The books examined for the foregoing account, and to which the reader is referred for more minute particulars, are, *Antiquities of Westminster*; the literary part by J. S. Hawkins, esq.; plates from drawings by J. T. Smith; 1 vol. 4to. 1807. *The History of Henry VII.'s Chapel*, by J. Britton, with plan, views, elevations, &c.; in vol. ii. of *Architectural Antiquities of Great Britain*. *The History and Antiquities of the Abbey Church of St. Peter at Westminster*, 4to. 1818, &c., by E. W. Brayley; with numerous plates from drawings by J. P. Neale. *The History of the Abbey Church of St. Peter's, Westminster, its Antiquities, and Monuments*; in 2 vols. 4to., with 63 engravings; published by Mr. Ackermann. *An Inquiry into the Time of the first Foundation of Westminster Abbey, &c.*, by R. Widmore, 4to. 1743. Also, *The History, &c. of the Abbey Church*, by the same author, 1751. *Westminsterium, or the History and Antiquities of the Abbey Church of St. Peter, Westminster*, by John Dart; 2 vols. fol. 1723. The general histories have been already referred to in the article LONDON.

WESTMINSTER, a town of Massachusetts, in the county of Worcester, containing 1419 inhabitants; 55 miles N.W. of Boston.—Also, a post-town of Vermont, in the county of Windham, containing 1925 inhabitants; 18 miles N. of Brattleborough.—Also, a town of Maryland, with a post-office; 26 miles N.W. of Baltimore.

WESTMINSTER-Hall, an island in the straits of Magellan, situated to the N.E. of Cape Pillar. S. lat. $52^{\circ} 34'$. W. long. $76^{\circ} 16'$.—Also, an island in the Mergui Archipelago. N. lat. $10^{\circ} 42'$.

WESTMORE, a town of the state of Vermont, in Essex county, containing 71 inhabitants; 65 miles N. of Norwich.

WESTMORELAND, WESTMORLAND, or *Westmoreland*, a northern county of England, surrounded by parts of Durham and Yorkshire to the N., N.E., and E.; by Lancashire to the S. and to the S.W.; and by Cumberland on the W. and N.W. The greater part of the boundary line is artificial; but at the S. and S.W., rivers and lakes constitute natural lines of demarcation. This district is supposed to have derived its name from being a western moorish country; perhaps it was the land of the moors or lakes in the west. It formed a part of the territory of the *Brigantes* in that district occupied, according to Richard of Cirencester, by the *Voluntii* and the *Sistuntii*. The *Brigantes* were the principal inhabitants of the Roman province *Maxima Caesariensis*; and during the heptarchy were included in the extensive kingdom of Northumberland. In the time of Edward the Confessor, this kingdom was divided into six shires, of which one was called "*Appulbifchire*, to which belonged the land of Westmoreland." In this division, however, Kendal and its district were not included; for

long after the Norman Conquest, they were reckoned to be long to the hundred of Lonsdale, in Lancashire. Of the Roman establishments in Westmoreland, many noticeable vestiges are to be found in stations, forts, roads, inscriptions, and other remains. Among the stations, or towns, may be mentioned *Amboglana*, a name supposed to be still preserved in Ambleside, at the N. end of Windermere; but Horsley places *Diſis* at that town. At any rate, bricks, urns, coins, and other relics, sufficiently prove it to have been occupied by the Romans. *Vertera*, another Roman station, was situated where now stands Brough-under-Stanmore, a name announcing an ancient fortification. *Aballaba* seemed naturally to have given rise to the modern name of Appleby; but no Roman remains have ever been found at that place, although it be undoubtedly of considerable antiquity. *Galacum* is by Camden placed at Whelley; but by later writers near Appleby. *Brovacum* is probably Brougham castle, near Penrith. This station has often been confounded with *Brogonaca*, of which remains exist in Kirkbythore. This station Whelley or Whelp castle lies in the middle of the village, and is commonly called High Burwens. It occupies an advantageous position; the extent from west to east is about 160 yards. The foundations of the vallum are very plain. Among the inscriptions found in it is one *Fortuna Servatrice*. A branch of the great Roman road, called the Watling-street, passed through the county from Stanmore to Brougham castle; and until the modern turnpike-road was made, the former was very conspicuous almost all the way. Between Brough and Kirkby, parts of it are still to be observed; keeping, as was the practice of the Romans, a straight course, regardless of difficulties. This road measured about six yards in width, and is described to have been formed, in many places, by three courses of large square stones. Near the northern border of the county, and not far from Kirkbythore, is a large encampment, attributed to the Romans, and measuring about 300 yards in length, by 150 in breadth. It is represented as having twelve entrances, with bastions to each; but this is improbable. Some topographers describe a few of the antiquities of the county as of Celtic, or Druidical origin; particularly "a sort of Druidical place of worship near Shap." Maybrough castle, and Arthur's Round Table, near Penrith, are referred to the British era. There are also several cairns, or heaps of loose stones, in the county. At Kirkbythore, a Roman road, called the Maiden-way, branched off, and passing over the lower end of Cross-fell, terminated at Caer-vorran, in Northumberland. Roman inscriptions have been found in various parts of the county. One in particular was discovered at Kirkbythore, inscribed *Deo Belatucadro*, a local divinity probably of the original Britons. In 1739, at the same place, was found a stone inscribed *Jovi Serapi*. In the manor of Milbourn was found an altar to *Silvanus*, within a round fort surrounded by deep ditches, called Green-castle. This county is divided into the two baronies of Kendal and Westmoreland, the latter of which is occasionally called the barony of Appleby; and these again subdivided into the four wards of East, West, Kendal, and Kirkby Lonsdale. In ancient times, the Kendal barony was deemed part of the county of Lancaster. In the Domesday survey, an account is taken of some places in the barony of Kendal, with some neighbouring property in Lancashire and Yorkshire; but the Westmoreland district is unnoticed in that record, and thence supposed to have been uninhabited and waste at the time of the Conquest. The Kendal barony is in the diocese of Chester, and consists of two rural deaneries; whereas the other barony is within the diocese of Carlisle, and consists of one

WESTMORELAND.

one rural deanry. The whole county contains only thirty-two parishes. According to the census of 1811, these contained 9064 houses, and 45,922 inhabitants.

The general appearance of Westmoreland is marked with some of the strongest features in nature; immense tracts of mountains, beautiful but contracted valleys, extensive lakes, and large rocky districts, which contain many high, steep, and bulging crags. The county is not only encircled with mountains, but the greatest part of its interior surface is swelled into hills. A long range of heavy-looking hills bounds the eastern side of the county; in front of which is an extensive tract of tolerably level ground. The rest of Westmoreland is almost wholly hill and dale. The farm-houses and those of the small villages, covered with blue slate and whitened with lime, are seated about the bases of the hills, with their small irregular fields spreading up the sides of the mountains, and almost universally divided with stone-walls. This last circumstance gives the country a naked appearance; but the numerous tracts of woodland interspersed tend to enliven the scene. Every dell or hollow has its little brook, and the smallest of these are plentifully supplied with fish. Several low heathy commons are seen towards the eastern side of Westmoreland; and the western part is characterised by high rugged prominences, and even some rocky plains, small coppices, and a large extent of low flat peat-mofs; on the north, the fine woods about Lowther add a striking feature to the landscape. Such are the brief but general outlines of the picture: we proceed to particularise some of its peculiar characteristics, the most prominent of which are its *Mountains*. These are provincially called *fells*, of which the following are the most noted.

Farlton-knot, near the borders of Lancashire, is a very protuberant lime-stone rock; from the Kendal road, near Burton, it is said to have very much the appearance of the rock of Gibraltar.

Whitbarrow-scar is also a very high rock, and in some parts presents a perpendicular face of solid lime-stone. It rises its grizzly front between Milnthorp and Cartmel. The high road leads along its base, whence it presents a grand, and in some places a tremendous aspect.

Langdale-pikes, in the western corner of the county, are conical hills of great height, with pyramidal rocky tops, and are situated in the interior parts of a very mountainous district; their sides and bases are verdant, and have formerly been covered with wood.

Hill-bell is also a high conical-topped mountain, about four miles east from Amblefide.

Harter-fell, High-freet, and Kidsey-pike, are stupendous heights, within a few miles of the southern end of Haws-water. From the top of High-freet, thirteen lakes, and the sea in several directions, may be seen.

The chain of hills on the east, which is continued north and south through other counties, presents a heavy and regular appearance; and they have mostly mossy and heathy tops, except two or three conical green hills opposite Appleby. They are in general picturesque; some with abrupt declivities, or rocky fronts, form high precipices, or in bulging shattered crags project over the vales in a frightful manner; while others shew smooth, verdant, and swelling surfaces, beautifully spotted with flocks of sheep and herds of cattle.

There are few Caves in Westmoreland; one, however, is to be found at Dun-fell, bordering on Cumberland, and is of considerable extent. So intricate are the different passages and chambers of this capacious cave, that the Rev. William Richardson is said to have been seven hours in examining its varied parts. He describes the roof in some

parts to resemble pointed arches, in others flat surfaces: he found in some places the *stalactites*, and pieces of *rhomboidal spar*. He travelled nearly two miles in a right line, and discovered evident marks of some of the chambers having been filled with water. The highest part of the vault is rather more than 25 yards; the breadth in some places about 150 yards; in other parts there was scarcely height sufficient to creep through the hollow. Some other visitors have mentioned the astonishing lustre of the spar with which these vaults are encrusted. Nicholson and Burn, in their "History of Westmoreland," mention three pits, one of which is generally considered unfathomable. In the season of salmon smelts, these pits abound with those smelts, when they are to be seen also in the river Kent, which induces a belief that they arrive from thence in subterraneous passages.

Rivers.—Although the rivers or streams, (provincially called *becks*,) are numerous, they are but small, and mostly rise within this district. Only three of these are sufficiently important to retain their original names from their sources to the sea. These are, the Eden, the Lune, and the Kent, or Ken. The first springs in Mallerstang, and runs north, and having received in its course, besides many lesser streams, the conjoined rivers of Lowther and Eamont, enters Cumberland, which county it traverses in its course to the sea, at Rowcliff. The Lune, or Lun, hath its source in Ravenstonedale, and passing to the south, through a fine vale, to which it gives name, enters the county of Lancaster, formerly called Loncaster. The Ken, or Kent, has its origin in Kent-mere, and runs through a valley, called Kendale; passes the town of Kendal, and empties itself in the sea at Cartmel bay. The different rivulets from the eastern district empty themselves into the Eden, which, during its course through this county, receives its principal supplies. An irregular line, drawn east and west through the centre of Westmoreland, divides the direction of its several rivers: those on the north falling into the Eden, either before or at its entrance into Cumberland, except two or three small branches of the Tees, which rise on the eastern ridge of hills on the borders of the county of Durham. The rivers on the southern parts take a contrary direction, and enter the sea at different places.

The Lowther has its source in the Moors, above Wetsladdale, and passing Rosgill-hall, there unites with Swindale-beck, which rises near the slate-quarries; with the augmentation of a few other streams, it joins the Eamont.

The Eamont emerges from Ulls-water, and forms a boundary to parts of this county and Cumberland; and after being augmented by the waters of the Lowther river, which descends from the centre of the county, it joins the Eden as it enters Cumberland.

The Loyne, or Lune, has been described in a previous volume of this work, under LANCASTHIRE.

The Crake, a brook or rivulet, descending in several heads from a variety of dells on the side of Brackenthwaite-fell, passes through a very extensive peat-mofs to the Ken, just before its influx to the sea.

The Winter, or Winfler-beck, forms the boundary between the lower part of Westmoreland and Lancashire. It rises on the hills about two miles east from Windermere lake, and directs its course southwards, when it discharges itself in an estuary of the sea.

The Trout-beck is a brook issuing from the mountain High-freet, and unites itself with Windermere lake.

Rothay springs on the borders of Cumberland, among a number of high mountains; it runs several miles westward, and receives various streams in its progress to Grafmere.

Lakes.—Westmoreland is deservedly celebrated for its
fine

fine lakes. Among these, Windermere, or Winandermere, and Ulls-water, merit particular attention for size, and for the picturesque beauty of the scenery which furrounds them. They may be, and are by competent judges, regarded as unequalled in the kingdom.

Winandermere is a large lake of about ten miles and a half in length, by a breadth of from one to two miles; including an area, or sheet of water, of nearly 4534 acres. Its depth is in one place 23 fathoms, in a second 29, and in a third 31 fathoms. Four mountain streams, or rivers, supply this lake, and it is singular that its waters scarcely ever appear to be augmented or decreased. "Even in the most violent rains, when the country is drenched in water, when every rill is swelled into a river, and the mountains pour down floods through new channels, the lake maintains the same equal temper; and though it may spread a few yards over its lower shores, (which is the utmost it does,) yet its increase is seldom the object of observation; nor does the severity of the greatest drought make any considerable alteration in its bounds." In this lake are thirteen islands, the largest of which is now called Curwen's island. It contains about 27 acres of land, which are laid out in pleasure-gardens, walks, &c. around a very handsome mansion belonging to Mr. Curwen.

Ulls-water, part of which is known by the name of Ousemere, is a large and long lake, situated at the north-western extremity of the county, and partly in Cumberland. Next to Windermere, it is the largest sheet of water in this part of England. It covers an area of about nine miles in length from N.E. to S.W. by two in the broadest part, though the general width rarely exceeds a mile. Its sides are very irriuous, and from its shores the mountains rise in various bold, picturesque, and romantic forms; occasionally starting abruptly from the lake, and in other places ascending by gradual slopes. Towards the south-western end the mountains are on the grandest scale. On the northern and western sides the scenery is mostly rocky and woody. In some places its waters are from 29 to 35 fathoms deep. It abounds with trout, perch, skellies, and eels; also some char, and a large species of trout, some of which have been caught of ten pounds weight. In its highest part are a few small rocky islands.

Haws-water, in beauty and extent, ranks next. This lake is situated between Shap and Ulls-water, in a mountainous district; it is about three miles in length, and in breadth from a quarter to half a mile. The hills on the east side are high and rocky, and partially covered with wood. Those on the west are also high, but have a portion of low cultivated ground along the margin, which is divided into small farms. The narrowest part of this lake is said to be fifty fathoms deep.

Grafmere lake is a small but beautiful sheet of water, about a mile in length, and nearly half a mile broad, having its margin indented with numerous small bays with lofty and rocky eminences. Its situation is a few miles north of Ambleside. Near its centre is a small green island. The poet Gray describes this lake and its scenery in terms of high panegyric. "After passing the romantic mountain of Helm-Crag," he says, "opens one of the sweetest landscapes that art ever attempted to imitate. The bosom of the mountains here, spreading into a broad basin, discovers in the midst Grafmere-water; its margin is hollowed into small bays with bold eminences, some of rock, some of turf, that half conceal and vary the figure of the little lake they command. From the shore a low promontory pushes itself far into the water, and on it stands a white village, with the parish-church rising in the midst of it."

South of this, in the same vale, is Rydal-water, a small lake nearly a mile in length, and interspersed with wooded islands. Its water is shallow, and abounds with reeds.

On an elevated situation, nearly two miles west from Ambleside, is a small lake called Elter-water.

Broad-water is a small lake half a mile long, and a quarter of a mile broad, situated a few miles above Ulls-water.

Kentmere-tarn, a piece of water upwards of a mile long, and nearly half a mile broad, is situated in Kentmere-dale.

Skeggles-water, a very small lake, three miles north-east of Kentmere-tarn, is embosomed in the mountains of Longsleddale.

Sumbiggin-tarn, and Whin-fell-tarn, are small pieces of water; the former four or five miles east from Orton, well supplied with eels and a red trout, resembling char; and the latter about five miles north-east from Kendal.

The soil of Westmoreland is mostly dry and gravelly; but in the east and north, sand and hazel-mould are found. Clay prevails on a few farms towards the Eden and the eastern hills; and a moist soil appears in some northern districts. Peat-moss abounds on the tops of some high mountains, consisting of a dry soil upon a hard blue rock, provincially called *rag*. The soil that lies upon a stratum of lime-stone is esteemed the most profitable.

The Roads in Westmoreland, from the rocky nature of the country, are very firm and good. They are generally formed to wind gradually round the sides of the hills and along the vales, in such a manner, that the declivities of the former are mostly avoided. The principal roads leading through this county are those from Scotland and Cumberland to London, and the southern parts of England. These roads are united through Cumberland, but divide near Penrith, on the confines of Westmoreland: one turns eastwards, over Stainmoore, and through the centre of Yorkshire, to London, &c.; the other proceeds directly south, through Kendal, Lancaster, &c. to Manchester, Liverpool, Wales, the western counties of England, and also to London. A branch from this road goes through Kirkby-Lonsdale to the manufacturing towns in the West Riding of Yorkshire, and other southern districts.

Before the rebellion of 1715, the public roads of this county were almost impassable; but in that year the government planned several new roads: very little, however, was done to them before the more serious insurrection of 1745. This event impelled the government to direct some effectual repairs to be made. In 1774 an act of parliament was obtained to make a turnpike-road from Bowes to Brough. In this year, the first stage-coach from London to Glasgow was established to run this road. A mail began to travel through Kendal, &c. from London in 1786. Since which time the great roads have been kept in very good repair.

With the exception of some trifling veins of lead ore, few minerals have been found in the eastern part of this county. Coal is obtained only in the south-eastern extremity of Westmoreland, except an inferior quality called *crow-coal*, procured in the neighbourhood of Shap.

The county affords various sorts of valuable stone; particularly lime-stone, marble, gypsum, blue slate, and free-stone. There is great abundance of lime-stone, except among the western hills.

Marble of a beautiful kind was discovered a few years ago on the banks of the river Kent, near Kendal, and has been worked with success. The same vein has also been found on the opposite side of the river.

Blue slate of various sorts is dug from the rocky hills on the

the western side of the county; though great quantities are used in the country, yet much of the better sort is sent to London, Liverpool, Hull, and other large sea-ports. Beds of lime-stone are generally incumbent on beds of slate.

The buildings of Westmoreland are distinguished for their neat appearance. The houses are mostly built with lime-stone, or blue rag; thatched roofs are common, but slate is more generally used. In farm buildings, the barn is usually built upon the cow-house and stable, a method which requires the slope of a hill, as carts are carried along a level on one side into the barn. As very little corn or hay is stacked without, the barns are necessarily very spacious. There are many noblemen's and gentlemen's seats in this county; and also some pleasant villas which ornament the borders of the lakes.

The commerce of Westmoreland is not extensive. Its exports are chiefly a coarse woollen cloth, stockings, flates, tanned hides, gunpowder, hoops, charcoal, hams, wool, sheep, and cattle.

The manufactures of the county consist of silk and worsted waistcoat-pieces, knit worsted stockings, flannels, tanned leather, and gunpowder.

Formerly the whole county was governed by military tenure, *i. e.* by homage, fealty, and cornage, "which last drew after it wardship, marriage, and relief; and the service of this tenure was military service." Cornage appears to have been peculiar to the border-service against the Scots. Cornage, horn-geld, and nout-geld, were probably synonymous, and implied annual payments of horned cattle, to provision the garrisons. The lord's rent was called white-rent, probably from its being paid in silver. Scutage, or service of the shield, was another compensation in money, instead of personal service against the Scots.

Some veins of *copper* ore have been found and worked in different parts of the county; but the product has not been found sufficient to defray the expence of workmanship. Before the year 1704, great quantities of *lead* were found near Hartley. Some mines at Dunfell have proved very productive of this metal for many years, but latterly there has not been much ore found. At Dufton are some rich and productive lead mines, belonging to the earl of Thanet. There are some considerable mines at Greenside, near Paterdale, and at several other places in the county. This metal is obtained in various quantities.

Crofs-fell, the highest of the chain of mountains which extend along the eastern frontiers of the county of Westmoreland and Cumberland, is said by Robinson, in his Natural History of the County, to have been formerly called Fiend's-fell, from evil spirits which are said in former times to have haunted its summit, and continued their haunts and nocturnal vagaries upon it until St. Austin, as is reported, erected a cross, and built an altar upon it, whereon he offered the Holy Eucharist, by which he counter-charmed those hellish fiends, and disturbed their haunts. Since that time it has been named Crofs-fell; and unto this time there is a heap of stones on the summit, which bears the name of Crofs-fell.

Upon this and the adjoining mountains occurs the phenomenon, called the Helm-wind; which, in spite of St. Austin's charms, continues its vagaries on its ancient haunts. It is peculiar to this district, and the confines of Lancashire and Yorkshire, about Ingleborrow, Pendle, and Penigent. It also occurs on Wildboar-fell, in Ravenstonedale; and is most prevalent in the months from October to April. The appearances attending it are a whitish cloud hanging half way down the mountains, but keeping an exact parallelism with every plane, depression, and elevation of their tops,

which it covers as with a helmet. Above this appears the blue sky, and then a white cloud, called the helm-bar, from an idea that it represses the fury of the storm: it continues in a tremulous agitated motion till it disperses; and then the hurricane issues forth, roaring along the sides of the hills, and frequently extending two or three miles from their sides. The following are the heights of the principal mountains, as ascertained by Mr. Dalton. Helvellyn is 1070 yards high. A deep drift of snow was seen on this mountain on the 12th of July, 1812. Bowfell and Rydal-head are each 1030 yards in height. The High-freet is 912 yards high. On its summit are annual horse-races, and other sports, on the 10th of July, to which every one brings the sheep that have strayed into their heathing-ground, for their owners to challenge.

It appears that different grammar-schools were established in this county previous to the dissolution. Edward VI. was patron of the school at Kendal; and queen Elizabeth founded schools at Appleby, Kirkby Stephen, and Kirkby Loufsdale. From these seminaries many learned men have been distributed over England, some of whom have obtained eminence in the literary world. They have also contributed towards the establishment of other public schools in the county. Seminaries are, therefore, established in nearly every village in Westmoreland.—The History and Antiquities of the Counties of Westmoreland and Cumberland, by Joseph Nicholson, esq. and Richard Burn, LL.D. 2 vols. 4to. 1778. An Essay towards a Natural History of Westmoreland and Cumberland, by the Rev. Thomas Robinson, 8vo. 1709. General View of the Agriculture of the County, by Andrew Pringle, 4to. 1794. Observations relative chiefly to Picturesque Beauty of the Mountains and Lakes of Westmoreland and Cumberland, by the Rev. William Gilpin, 2 vols. 8vo. 1788. A Survey of the Lakes, by James Clarke, folio.

WESTMORELAND, a post-township of New York, in Oneida county; 10 miles W. of Utica, and 107 miles from Albany. Its waters are small; its surface very level, but the soil is very rich and fertile. It has a church for Congregationalists, and a competent number of common schools. In 1810, the population was 1135, and the senatorial electors were 141.—Also, a county of Pennsylvania, containing 26,392 inhabitants, of whom 20 are slaves.—Also, a county of Virginia, containing 8102 inhabitants, of whom 4080 are slaves.—Also, a township of New Hampshire, in the county of Cheshire, on the E. bank of the Connecticut, containing 1937 inhabitants; 5 miles N. of Chesterfield.

WEST NANTMILL, a township of Pennsylvania, in the county of Chester, with 1188 inhabitants.

WEST NORTHERN LIBERTIES, a town of Pennsylvania, in the county of Philadelphia, containing 9795 inhabitants.—Also, a township of the same, containing 168 inhabitants.

WEST NOTTINGHAM, a township of Pennsylvania, in the county of Chester, with 642 inhabitants.

WESTOE, a township of Durham, with 2900 inhabitants; 2 miles S. of Shields.

WESTON, a township of Connecticut, in the county of Fairfield, with 2618 inhabitants; S. of Fairfield.—Also, a town of Vermont, in the county of Windsor, containing 629 inhabitants; 30 miles N.N.E. of Bennington.—Also, a town of the state of Massachusetts, in the county of Middlesex, containing 1008 inhabitants; 12 miles W. of Boston.

WEST PENNSBOROUGH, a township of Pennsylvania, in the county of Cumberland, with 1264 inhabitants.

WESTPHALIA, a circle of Germany, bounded on the

the N. by the Dutch states, on the W. by the Netherlands, and elsewhere by the circles of the Rhine, Upper and Lower. The ancient Saxons were divided into Westphalians, Angrians, and Eastphalians. The people inhabiting between the Wefer and the Rhine, were called *Westphalians*, and the tract of country inhabited by them, has from thence been called *Westphalia*. The duchy of that name, in the electoral circle of the Rhine, constituted a part of this country; but the circle of Westphalia comprised also under it other countries, which never belonged to the above-mentioned Westphalia. And thus we must carefully distinguish from each other the three denominations, which are, the circle of Westphalia, Westphalia itself, and the duchy of that name. Formerly, not only certain states were reckoned in this circle, which at present no longer belong to it, as Utrecht, Guelderland, Zutphen, the bishopric and city of Cambray; but in other respects, also, the ancient and the modern lists of the countries of the Westphalian circle differ greatly from each. The following appeared to be states of the Westphalian circle before the peace of Luneville, *viz.* the bishoprics of Paderborn, Munster, Liege, and Osnabruck; the duchy of Verden; the principality of Minden; the abbeys of Corvey, Stablo, Werden, Cornelius Munster, Essen, Thorn, and Hervorden; the duchy of Cleves, with the county of Mark; the duchies of Juliers and Berg, Nassau Siegen, and Nassau Dillenburg; the principalities of East Friesland and Meurs; the counties of Sayn, Wied-Runkel, Schauenburg, Oldenburg, Delmenhorst, Lippe, Bentheim, Tecklenburg, Hoya, Virnenburg, Diepholz, Spiegelberg, Rietberg, Pyrmont, Gronsfeld, Reckheim; the signories of Anhalt and Winneburg; the county of Holzappel; the signories of Witten, Blankenheim, Geroldstein, Gehmen, Gimborn and Neustadt, Wickerad, Mylendonk, and Reichenstein; the county of Kerpen and Lommerfum; the signiory of Schleiden, and the county of Hallermund, to which in the matricula are reckoned moreover to belong the signiories of Dyck, Severn, Kniphausen, Keyl, Mechernick, Eys, Schlenacken, Wylre, Richold, Dreyz, and Schonau, together with the cities of Cologne, Aix-la-Chapelle, and Dortmund. The summoning princes, and directors of the circle, were the bishop of Munster, and with him alternately the electors of Brandenburg and Palatine, as dukes of Cleves and Juliers, both of whom in this directory enjoyed together but one voice. The diets of the circle were usually appointed at Cologne. The archives belonging to it were kept at Dusseldorf. The contribution of this circle in men and money, to the aids of the empire, was made equal to the contributions of Upper and Lower Saxony, Burgundy, and Swabia, and rated at somewhat more than the ninth, but less than the tenth part of the whole sum granted by the empire. With respect to religion, this circle was one of the mixed. Indeed the Catholic states used to nominate two, and the Protestant also the like number of assessors, to assist at the Imperial and chamber court of the empire. By the peace of Luneville, all that part of the circle which lay on the left bank of the Rhine, was ceded to France.

WESTPHALIA, (*Duchy of*) a country of Germany, bounded on the N. by the bishopric of Munster and county of Lippe, on the E. by Paderborn, Waldeck, and Hesse; on the S. by Witgenstein, Nassau, and Berg; and on the W. by Berg and Mark; about forty miles in extent from N. to S. and thirty-two from E. to W. Agreeably to its natural situation, this county is divided into three parts. The first of these, called the *Hellwege*, is low, and produces plenty of corn and other necessaries, with a sufficient breed of cattle and salt-springs. The second is the *Haarfrank*,

which stands somewhat higher, between *Hellwege* and the *Sunderland*, and has indeed a good, but not so fruitful a soil as the *Hellwege*. The third is the *Sunderland*, commonly called the *Surland*, or *Saurland*, which consists of hills and vales. This tract indeed is neither of great, nor even a sufficient fertility in corn; but, on the other hand, it has fine woods and meadows, together with a good breed of cattle, game, and fish, in particular trout, as also plenty of iron ore, calamy, lead, copper, silver, and gold. The principal rivers are, the Ruhr, the Lenne, the Dimel, and Lippe. The duchy of Westphalia contains in it thirty-five towns. Henry, duke of Bavaria and Saxony, being put under the ban by the emperor Frederic I. in the year 1180, the latter made a donation of the duchy of Westphalia, as also a part of the duchy of Engern, which belonged to the former, to the archbishopric of Cologne, and invested therewith the archbishop Philip; concerning which donation, in the same year, a record, or instrument, was executed at Gelnhausen, and the said donation confirmed afterwards in the year 1200, by the emperor Otho IV., as also in the year 1204, by the emperor Philip. In the year 1368, Godfrey, the last duke of Arensburg, and his consort Anne, ceded the county of Arensburg to the archbishopric of Cologne; and, in the year 1371, the emperor Charles IV. invested the archbishop Frederic therewith. The county was afterwards added to the share of the duchy of Engern. The archbishops and electors of Cologne governed this duchy, till the year 1442, by marshals, but afterward under the direction of an electoral bailiff. Brilon is the capital. In 1802, the duchy of Westphalia was given to the prince of Hesse Darmstadt.

WESTPHALIA, a kingdom formed of several principalities, taken from the king of Prussia, after the battle of Friedland, and acceded to at the peace of Tilsit. Westphalia is divided into eight departments. 1. That of the Elbe; consisting of the greater part of the duchy of Magdeburg, with the Old Mark of Brandenburg. Its population is 253,000 souls: the chief place Magdeburg. 2. That of Fulda: the chief place Cassel. It is composed of a part of Lower Hesse, of the countries of Paderborn, Corvey, Minden, &c. Its population 239,502 inhabitants. 3. That of the Harz: chief place Heiligenstadt. It consists of Eichsfeld, of the cities of Mulhausen and Nordhausen, of the principalities of Hohenstein, Grubenhagen, Blankenburg, &c. Its population is 210,989 souls. 4. That of the Leine: chief place Gottingen. It is composed of a part of the principality of Grubenhagen, and of the countries of Hildesheim, Brunswick, and Hesse. Its population is 145,537 souls. 5. That of the Ocher: chief place Brunsvick. It is composed of the greater part of the duchy of Wolfenbittel, and the bishopric of Hildesheim. Its population is 267,878 souls. 6. That of Saal: chief place Halberstadt. It is composed of the principalities of Halberstadt, Wernigerode, Quedlinburg, &c. The population is 206,222 souls. 7. That of the Werra: the chief place Marburg. It consists of Upper Hesse, the Hersfeld, &c. The population is 254,000 souls. 8. That of the Wefer: the chief place Osnabruck. It consists of the bishopric of Osnabruck, a part of Schaumburg; and its population is 334,000 souls.

WESTPHALIA-Ham. See **HAM**.

WESTPOND PLANTATION, in *Geography*, a town of the district of Maine, in the county of Kennebeck, containing 481 inhabitants.

WESTPORT, a township of Massachusetts, in the county of Bristol, incorporated in 1787, with 2585 inhabitants; 60 miles S. of Boston.

WESTPORT, a sea-port and post-town of Ireland, in the county of Mayo, situated on a beautiful bay, wooded to the water's edge, in the S.E. angle of that large haven called Clew bay, founded by the late marquis of Sligo, whose residence was within half a mile of it. Westport is a neat regular well-built town, 123 miles W.N.W. from Dublin, and $8\frac{1}{2}$ S.W. from Castlebar. The following account, extracted from a late report to the Linen Board by Peter Bernard, esq. shews what judicious indulgence and liberal protection on the part of a landlord, assisted by the exertions of an industrious individual, may do. Were the example universally imitated, many squalid and decayed villages would quickly assume a more comfortable and exhilarating aspect. "The establishment and success of the linen manufacture in Westport, is due to the persevering attention of the marquis of Sligo and Robert Patten, esq. The latter, most fortunately for the neighbourhood, settled here in the year 1787; at that period Westport was a very inconsiderable town, containing but few houses, and its general market attended only by two or three hundred persons; now it is a beautiful well-built town, with 3700 industrious inhabitants, and many gentlemen of the highest respectability residing in it. Its market at present (1817) is attended by from 4000 to 5000 persons, whose manners, appearance, and dress, bespeak most strongly the happy effects of a well-regulated system of industry." "The first linen-market was held in 1790. For the first five years it produced only eight webs *per* week, and Mr. Patten was the only buyer; but he, by giving fair and liberal encouragement to the weavers, gradually but firmly advanced the trade, which now stands on a foundation not likely to be shaken. An accession of settlers from Ulster in the years 1797, 98, and 99, who brought their looms, some capital, and their accustomed habits of industry, completed what Mr. Patten had so fortunately begun." At present the market is held every Thursday in a spacious linen-hall built by the marquis of Sligo, where the goods are measured by a machine. The linens are all seven-eighths of three different qualities, and are all brought to market in a brown state. There are sold weekly about 200 webs, the value of which is estimated at above 20,000*l.* *per annum.* There are about 150 weavers and about 20 buyers, two of whom have bleach-greens at Westport. Mr. Patten has also successfully introduced at Westport the provision and corn-trade, and also the oil business, which is carried on to a considerable extent, and gives employment in the season to a great number of fishermen and boats. In March and April a number of fish appear off the coast, which, from their appearing only on a sunny day, the inhabitants call *sun-fish*, though they differ from the fish usually so called. The fishermen strike these with harpoons, then cut out the liver, and abandon the rest of the fish, the liver being sufficient to load one boat of four tons burden. A large fish yields eight barrels of oil and two of sediment. This trade amounts to some thousands annually, and Mr. Patten's house has often bought in one year near 3000*l.* worth. The oil is esteemed as good as spermaceti oil, and is particularly well-suited for lamps, as it has no offensive smell. The price of the present day is five shillings *per* gallon; the dregs are used by tanners. Bernard's Report to the Linen Board in 1817.

WESTRAY, one of the Orkney islands, terminating the cluster on the N.W. quarter, is situated 20 miles N. from Kirkwall, and 347 miles in the same bearing from Edinburgh. Its shape bears some resemblance to that of a cross; of which the longer part extends about eight miles, the arms or transverse part not more than five, and comprehends in the whole about fourteen square miles. The island

comprises two parishes, St. Mary's and Cross Kirk; and in the population return of the year 1811 was stated to contain 248 houses, and 1396 inhabitants. The only manufacture is that of kelp, of which are produced on an average 300 tons annually. Much corn is raised, but of an indifferent quality; the grass is excellent for the dairy, and for the pasturage of black cattle; and the boisterous seas which surround the island afford great plenty of fish, of a very superior kind. On the east and south are two bays; but the only harbour that can be depended on is on the north-east, and this is fit for small vessels only: formerly it received ships of much greater burthen; but from the blowing of the sand the water has become so shallow, they are now compelled to anchor in a more open road. In two extensive plains near the sea-side, one on the south, the other on the north part of the island, a multitude of graves have been discovered, all formed in nearly the same manner; and, though tradition is silent, they were probably formed after a sanguinary conflict at some remote period: some of these graves, on the north side, have been opened, and were found to contain skeletons in a reclining posture, with weapons, domestic utensils, and several other articles, the use of which could not be ascertained.—*Beauties of Scotland*, vol. v. Orkneys, 1808. *Carlisle's Topographical Dictionary of Scotland*, 1813.

WESTRINGIA, in *Botany*, was so named by the author of the present article, in honour of Dr. John Peter Westring, physician to the king of Sweden, member of the Royal Society of Stockholm, and author of several learned papers on the *Lichen* tribe, published in the *Transactions* of that body. He has also published seven numbers in 8vo. on the dyeing properties of many Swedish lichens, comprehending a full history of the modes of applying them to use, and accompanied with most elaborate and complete coloured figures, drawn by the celebrated professor Acharius himself.—*Sm.* in *Stockh. Transf.* for 1797, 171. *Tracts* relating to *Nat. Hist.* 277. *Mart. Mill. Dict.* v. 4. *Brown Prodr.* Nov. *Holl.* v. 1. 501. *Ait. Hort. Kew.* v. 3. 372.—*Class* and order, *Didymia Gymnospermia*. *Nat. Ord.* *Verticillate*, *Linn. Labiate*, *Juss. Brown.*

Gen. Ch. *Cal.* Perianth inferior, of one leaf, tubular, somewhat bell-shaped, with five sides and five prominent angles, but no furrows, divided about half way down into five equal, erect, lanceolate, beardless segments, permanent. *Cor.* of one petal, ringent, twice as long as the calyx: tube the length of the calyx, hairy in the throat: limb two-lipped; the upper lip flat, erect, divided, rather the longest; lower in three oblong, equal, spreading, entire segments. *Stam.* Filaments four, shorter than the limb, divaricated, the two upper ones longest; anthers of the two upper stamens roundish, halved, those of the two lower deeply divided, imperfect. *Pist.* Germen in the bottom of the calyx, four-lobed; style thread-shaped, the length of the longer stamens; stigma small, cloven, acute. *Peric.* none, except the hardened calyx. *Seeds* four, obovate, naked.

Ess. Ch. Calyx five-cleft half way down, five-sided. Upper lip of the corolla flat, cloven; lower in three deep equal segments. Stamens distant; the two upper with halved anthers; two lower with divided abortive ones.

A genus of New Holland shrubs, chiefly from the colder parts of that country, having the appearance of our rosemary, destitute of glands, but mostly downy. *Leaves* whorled, entire. *Flowers* axillary, solitary, on short stalks, with a pair of *bractes* close to the calyx. *Corolla* white, sometimes dotted with purple or violet. One species only was, for a long time, known to us, but Mr. Brown has

ascertained seven more, one of which, it seems, was brought home by the famous old navigator Dampier, and is preserved in the Sherardian herbarium at Oxford, if we remember right. They all very much resemble each other in habit, and prove the genus to be perfectly natural, though it has been confounded with *Cunila* by some very eminent botanists.

1. *W. rosmariniformis*. Rosemary-leaved Westringia. Sm. in Stockh. Transf. for 1797, 175. t. 8. f. 2. Tracts 282. t. 3. Brown n. 1. Ait. n. 1. Donn. Cant. ed. 5. 141. (*W. rosmarinacea*; Andr. Repof. t. 214. *Cunila fruticosa*; Willd. Sp. Pl. v. 1. 122.)—Leaves four in a whorl, lanceolate, revolute; shining and nearly smooth above; silky beneath. Calyx silky; its teeth longer than the tube.—Native of New South Wales, near Port Jackson, from whence specimens and seeds were sent by Dr. John White, in 1791. The stem is shrubby, several feet high, very much branched; branches either opposite, or four together, square, silky with white close hairs, densely leafy. Leaves spreading, an inch or somewhat less in length, acute, single-ribbed, entire; dark green, and polished above; white with silky hairs beneath. Footstalks broad and very short, silky, without stipulas. Flowers about the upper part of the branches, shorter than the leaves; their corolla spreading nearly an inch, white, dotted about the mouth with violet spots. Anthers violet. The calyx is silky on the outside of the tube, its segments naked with revolute margins; they appear to us variable in length. The plant is slightly bitter, not aromatic; nor have the flowers any scent.

2. *W. Dampieri*. Dampier's Westringia. Br. n. 2. Ait. n. 2.—“Leaves four in a whorl, linear, strongly revolute; nearly smooth above; hoary and opaque beneath. Calyx hoary and opaque; its teeth half the length of the tube.”—Gathered by Mr. Brown on the southern coast of New Holland. Sent to Kew in 1803, by Mr. Peter Good. It flowers in the greenhouse, from May to July. Aiton.

3. *W. rigida*. Rigid Westringia. Br. n. 3.—“Leaves three in a whorl, linear-lanceolate, divaricated, sharp-pointed, revolute; smoothish above; hoary beneath. Calyx hoary; its teeth half the length of the tube.”—Discovered by Mr. Brown, in the south part of New Holland.

4. *W. cinerea*. Grey Westringia. Br. n. 4.—“Leaves three in a whorl, linear, spreading, pointed, revolute, hoary on both sides. Calyx hoary; its teeth scarcely a quarter the length of the tube.”—This was found by Mr. Brown, in the same country as the last species.

5. *W. angustifolia*. Narrow-leaved Westringia. Br. n. 5.—“Leaves three in a whorl, linear, spreading, revolute; roughish on the upper side; hoary beneath. Calyx hoary; its teeth half the length of the tube.”—Found by Mr. Brown, in the island of Van Diemen.

6. *W. longifolia*. Long-leaved Westringia. Br. n. 6.—Leaves three in a whorl, linear, revolute; rough with minute points on the upper side; slightly hairy beneath. Calyx somewhat hairy; its teeth equal to the tube.—Gathered near Port Jackson by Mr. Brown. We have specimens, gathered in that country by Dr. White, which answer to the specific character, except that the back of their leaves, as well as the calyx, are rather hoary than, as Mr. Brown says, green, and the leaves are four, or even five, in a whorl. The corolla is externally downy; but this last character is, perhaps, not peculiar to the present species.

7. *W. glabra*. Smooth Westringia. Br. n. 7.—“Leaves three in a whorl, linear-lanceolate, flat, smooth on both sides, as well as the calyx.”—Gathered by Mr. Brown, in the tropical part of New Holland.

8. *W. rubifolia*. Madder-leaved Westringia. Br. n. 8.—“Leaves four in a whorl, elliptic-lanceolate, nearly flat, very smooth and shining. Calyx nearly smooth.”—Found in the island of Van Diemen, by Mr. Brown.

The two last species seem to differ remarkably from all the foregoing, in the flatness and smoothness of their leaves.

WESTRIZ, in *Geography*, a river of the duchy of Stiria, which runs into the Luffnitz, near Furtzenfeld.

WESTS, a town of Virginia; 4 miles S.W. of Leesburg.

WEST SALEM, a township of Pennsylvania, in Mercer county, with 660 inhabitants.

WEST SOUTHWARK, a town of Pennsylvania, in the county of Philadelphia, containing 6443 inhabitants.

WEST SPRINGFIELD, a town of Massachusetts, in the county of Hampshire, containing 3109 inhabitants.

WEST STOCKBRIDGE, a town of Massachusetts, in the county of Berkshire, containing 1049 inhabitants.

WEST WHITELAND, a township of Pennsylvania, with 636 inhabitants.

WEST WINDSOR, a town of New Jersey, in the county of Middlesex, containing 1714 inhabitants.

WET AIR. See MOISTURE.

WET Couch, a term used by the maltsters for one of the principal articles of malt-making.

In the making of malt, the usual way is to soak the grain in water two or three days, till it becomes plump and swelled, and the water is brown; the water is then drained away, and the barley is removed to a floor, where it is thrown into a wet couch, that is, an even heap of about two feet thick.

In this heap the barley spontaneously heats, and begins to grow, shooting out first the radicle, and, if suffered to continue growing, soon after the blade; but at the eruption of the radicle, the process is to be stopped short, by spreading the wet couch thin over the floor, and turning it once every four or five hours for two days, laying it thicker each time; after this it is thrown into a large heap, and there suffered to grow hot of itself, and afterwards spread abroad again and cooled, and then thrown upon the kiln to be dried crisp, without scorching. Shaw's Lectures, p. 186.

WET Dock. See DOCK.

WET-Glover, a dresser of the skins of sheep, lambs, goats, &c. which are slender, thin, and gentle.

WETA, or WINDAU, in *Geography*, a river of the duchy of Courland, which runs into the Baltic, a little below Windau.

WETERFELD, a town of Bavaria, on the Regen; 21 miles N.E. of Ratibon.

WETHER-GETTER, among *Sheep-Farmers*. See RAM.

WETHER-Sheep, in *Rural Economy*, a term applied by stock-farmers to a castrated male sheep of more than one year old; but before that time it is called a wedder-lamb. The wethers of the improved breeds of sheep, especially those of the new Leicester sort, are much more early than the old kinds. See SHEEP.

WETHERBY, in *Geography*, a market-town in the upper division of the wapentake of Claro, West Riding of the county of York, England, is situated on the river Wharfe, 7 miles N.W. from Tadcaster, about the same distance S.E. from Knaresborough, and 194 miles N.N.W. from London. The course of the river forms an angle, whose sides are each about one mile in length; at the point of this angle the town is seated. It affords nothing worthy of notice, but a handsome bridge crossing the Wharfe. Above this bridge the river forms a beautiful cascade, by falling

falling in a sheet of water over a high dam erected for the convenience of the mills. Over this cascade, the salmon, in their way up the river from the sea, are seen to leap with wonderful dexterity. Wetherby has a weekly market on Thursdays, and three annual fairs. In the population return of the year 1811, the town is stated to contain 1140 inhabitants, occupying 243 houses. In the time of William the Conqueror, this manor was possessed by two Norman lords, William de Percy and Erneis de Burun. It was afterwards given to the knights templars; and, together with all their estates in England, was forfeited on the abolition of their order, in the year 1312. In the civil war of Charles I. this town was garrisoned by sir Thomas Fairfax, who, in 1642, repulsed sir Thomas Glenham, in two different attacks. A little below the town is St. Helen's Ford, where the Roman military-way crossed the Wharfe. Within a mile of the town is Wetherby Grange, the seat of Richard Thompson, esq. In the park is an heronry, a thing rather uncommon in this part of the country. The herons build their nests in the tops of the highest trees; but seldom take the trouble, when they can get them ready made by the rooks, whom they expel, and enlarge and line the nests, driving away the original possessors, should they happen to renew their fruitless claims.

About two miles to the west of Wetherby, is Stockeld park, the seat of William Middleton, esq. His ancestors descended from Hypolitus de Brame, lord of Middleton, who lived in the reign of Henry II. Not far from the house, and near the high road, is a rock of a very singular shape, 65 feet in circumference, and 30 feet high, standing on the margin of a lake.—Hargrove's History of Knaresborough, 1809. Beauties of England and Wales, vol. xvi. Yorkshire. By J. Bigland, 1812.

WETHERSFIELD, a town of Connecticut, in the county of Hartford, containing 3961 inhabitants.

WETMORE'S ISLAND, a small island on the coast of Massachusetts, at the mouth of the river Penobscot.

WETSTEIN, JOHN JAMES, in *Biography*, was born at Basle in 1693, and made such proficiency in his early studies, that he was fit to be admitted into the university at the age of eleven years. In his 20th year he was ordained minister, on which occasion he maintained a disputation on the various readings of the New Testament, in which he defended the authenticity and integrity of the text. To this course of study he was sedulously devoted, and in order to explain the words and phrases of the New Testament, he carefully read the Greek authors, both sacred and profane; and he also consulted the Rabbinical writings, for the purpose of acquainting himself with the opinions and customs of the Jews. Richly furnished with this kind of knowledge, he set out, in 1714, on a literary tour to Zurich, Berne, and Geneva. From the latter place he proceeded through Lyons to Paris, where he became acquainted with Montfaucon, Courayer, and other eminent men; and he also visited England, where he was particularly noticed by the celebrated Bentley, and diligently searched for MSS. of the New Testament. During his stay in this country, he was made chaplain to a regiment of Swift's troops, and having obtained leave of absence, visited Paris, in order to collate a particular MS., and, after three months, joined the regiment at Bois-le-duc. Having afterwards visited Holland and Germany, he returned to Basle in 1717, and became deacon to the church of St. Leonard, which office he held with distinguished approbation for nine years. In pursuance of his main object, he corresponded with Bentley on the subject of various readings; but he was interrupted in his plan by a violent dispute with a divine of Basle, who had

been his intimate friend, occasioned by his publication of a specimen of his various readings in 1718. In the progress of this dispute, the clergy took a part, and presented a petition to the council, requesting that Wetstein's edition of the New Testament might be prohibited; alleging, amongst other objections, that it favoured of Socinianism. His Prolegomena, however, were printed in 1730, and a new accusation was preferred to the council against the author. This kind of clamour proving ineffectual, his enemies engaged some of his pupils to appear as witnesses against him; and they produced extracts of his lectures from the MS. copies of these pupils to support their accusation. The result of these dishonourable proceedings was a suspension of his functions in 1729, and this was soon followed by his total deposition. This conduct of the clergy was aggravated by a variety of misrepresentations; the ministers of Mulhausen, Neufchatel, Vallangen, and Geneva, expressed their disapprobation of these measures; and forty heads of families in the parish of St. Leonard presented a petition for obtaining Wetstein's re-establishment. But as this interposition on his behalf was unsuccessful, he left his native country, and removed to Amsterdam, where the Remonstrants elected him professor of philosophy in the room of Le Clerc, requiring, at the same time, that he should justify himself, either by a public apology, or before the council at Basle. Adopting the latter method, he returned to Switzerland, and in the presence of thirteen commissioners, chosen from the council and body of the professors, he shewed that the extracts furnished by his pupils were not worthy of credit; that the witnesses had sworn nothing that could prove the accusation alleged against him; and that the acts of the divines contradicted each other. The council, in March 1732, annulled the decree of condemnation, and restored him to the full exercise of his functions. The Remonstrants at Amsterdam were satisfied, and in 1733 he took possession of his office, the duties of which he faithfully discharged till his death. His character being re-established at Basle, he was elected in 1744 professor of the Greek language; but the Remonstrants, in order to retain him, nominated him professor of ecclesiastical history, and made an addition to his salary. Amidst the labours of the offices, which he sustained with great honour to himself and benefit to his pupils, he proceeded in collecting and arranging his various readings of the New Testament; grudging no expence, and availing himself of every opportunity that occurred in collating various MSS. Encouraged by a great number of learned men in England, Holland, and Germany, he at length published his first volume in 1751, and the second in the following year; and in order to preclude every objection, he printed the text from that commonly received, and the various readings at the bottom. To the whole he subjoined a commentary, comprehending all the remarks with which he had been furnished by the Hebrew, Greek, and Roman writers whom he had consulted. His attachment to received principles is evinced by his mode of explaining several passages, and particularly those which related to the divinity of Jesus Christ. To his New Testament he added two epistles of St. Clement, now first published, with a Latin version, and a dissertation on their authenticity. His literary reputation being now established, he was made a foreign associate of the Academy of Sciences at Berlin, in 1752; and in the following year elected a fellow of the Royal Society in London. Although Wetstein's constitution was vigorous, his incessant labour accelerated the infirmities of age; and he was seized with a numbness and coldness in his right leg, which threatened a gangrene, and all attempts to check the progress of this malady were ineffectual; so that it terminated his valuable life

in March 1754, in the 61st year of his age. He beheld the approaches of death with tranquillity and resignation. Wetstein was social, and fond of innocent amusements, though studious. He was an excellent Greek scholar, possessed a retentive memory, and spoke several modern languages. He was affable even to strangers, and kind and condescending to his pupils. His benevolence comprehended all of every nation and communion, and he was prompt in communicating assistance and advice to all who applied to him. His character has been amply vindicated from invidious and degrading charges by Kriehout, in his "Memoria Wetsteiniana Vindicata," 4to. Formey's Elog. Gen. Biog.

WETTELSHEIM, in *Geography*, a town of Germany, in the principality of Anspach; 4 miles N.W. of Treuchtlingen.

WETTENHAUSEN, a princely abbey, founded in the tenth century; 20 miles W. of Augsburg.

WETTER, a town of Germany, in the county of Mark; 6 miles S.W. of Schwiert.—Also, a town of Germany, in the principality of Hesse; 6 miles N.W. of Marburg. N. lat. $50^{\circ} 54'$. E. long. $8^{\circ} 45'$.—Also, a river of Germany, which rises in the county of Solms, and runs into the Nidda, at Assenheim.

WETTER *Island*, an island in the East Indian sea, about 90 miles in circumference, of an irregular form. S. lat. $7^{\circ} 24'$. E. long. $126^{\circ} 40'$.

WETTER *Lake*, a lake of Sweden, in East Gothland, sixty-five miles long, and from ten to sixteen wide. This lake has but one outlet by the river Motala, though above forty little streams discharge themselves into it. This lake lies much higher than either the Baltic or the North sea, and is deep and clear, but very boisterous in winter. It is supposed certainly to prognosticate the approach of stormy weather. As this lake, like all inland pieces of water, surrounded with hills or mountains, is subject to sudden storms in the stillest weather, superstition and credulity co-operating, as in other cases, have been busy in explaining and admitting causes for this phenomenon; and accordingly it has been reported and credited, that these sudden storms are occasioned by a subterraneous communication with the lake of Constance in Switzerland. It is said, that by a regular series of correspondence and observation it was found, that when the waters of one lake arose, those of the other fell in the same proportion; and frequently the waters of the Wetter were violently agitated without the least wind, or any apparent cause, until information arrived that at the same time the lake of Constance had been disturbed by a tempest. The whole is supposed to be a fable grounded on some antiquated tradition. See WADSTENA.

WETTERAU, or WETTERAVIA, a country of Germany, situated between the county of Hesse and the river Maine, which takes its name from the river Wetter. It contains the counties of Siegen, Schaumburg, Dillenburg, Dietz, Hadamar, Weilburg, Idstein, Hanau, Solms, Wetterburg, Isenburg, Sayn, Witgenstein, Hohenstein, Cronberg, and Waldeck, the lordships of Weid, and the imperial towns of Wetzlar, Friedberg, and Gelnhausen. The northern part is called Wetterwald.

WETTERINGEN, a town of Germany, in the bishopric of Munster; 7 miles S.W. of Rheine.

WETTING, a town of Westphalia, in the duchy of Magdeburg, on the Saal, the principal place of a bailiwick, which was formerly a county, in the year 1283 granted to the cathedral of Magdeburg. In the neighbourhood are some coal-mines; 34 miles S. of Magdeburg. N. lat. $51^{\circ} 37'$. E. long. $12^{\circ} 3'$.

WETTINGEN, a town of Switzerland, and principal

place of a bailiwick, in the county of Baden, on the Limmat, with a celebrated wooden bridge of one arch over the river, executed by the same person who built the bridge over the Rhine, at Schaffhausen; 1 mile S. of Baden.

WETZ, a river of Germany, which runs into the Lahn, near Wetzlar.—Also, a town of Germany, in the principality of Solms Braunsfels; 5 miles S. of Wetzlar.

WETZLAR, an imperial town of Germany, in the circle of the Upper Rhine, situated on the Lahn. The Roman Catholics, the Lutherans, and the Calvinists, have each a church; 45 miles E. of Coblenz. N. lat. $50^{\circ} 34'$. E. long. $8^{\circ} 33'$.

WEVELSBURG, a town and citadel of Westphalia, in the bishopric of Paderborn; 8 miles S. of Paderborn.

WEVER, a river of England, in the county of Chester, which runs into the Dee, 7 miles N. of Chester.—Also, a river of England, in the county of Devon, which runs into the Culm, near Bradninch.

WEVERHAM, a township of England, in Cheshire; 3 miles W. of Northwich.

WEVERY, a river of Wales, which runs into the Wye, near Builth.

WEWER, or WEVER, a town of Westphalia, in the bishopric of Paderborn; 22 miles S.S.W. of Paderborn.

WEWURTZE, a river of Lithuania, which runs into the Minnic, 3 miles S. of Proeculis.

WEXEL, a mountain of Stiria; 4 miles N.W. of Fridberg.

WEXFORD, a county of Ireland, in the south-east part of it, which has St. George's Channel on the E. and S., the counties of Waterford, Kilkenny, and Carlow, on the W., and that of Wicklow on the N. It extends from N. to S. 44 Irish miles, and from E. to W. 25; being 56 English miles in length, by 32 in breadth. It contains 342,900 acres, or 535 square miles Irish, equal to 550,888 acres, or 695 square miles in English measure. The number of parishes 142, having 41 churches, all of which, except two parishes with one church, are in the diocese of Farns. The population was estimated by Dr. Beaufort at about 115,000. Wexford forms almost a peninsula, being separated from Waterford and Kilkenny by the haven of Waterford, and the deep and navigable river Barrow, and from the counties of Carlow and Wicklow by formidable ranges of mountains, which admit of few passes. Being situated next to the principality of Wales, and nearly opposite to the mouth of the British Channel, it presented great advantages to the English invaders of Ireland in the reign of Henry II.; who, after their first victories over the natives, selected this county, from its natural strength, for the residence of the first colonists. The inhabitants of the baronies of Bargie and Forth are supposed to retain traces of their descent from these settlers. (See BARGIE.) Wexford cannot be called hilly or mountainous, except on the frontiers of Carlow and Wicklow. Yet it contains a great deal of coarse cold land, and stiff clay soil, which the want of lime-stone renders it difficult and expensive to improve. The baronies of Bargie and Forth, being of a lighter soil, are well tilled, and produce large quantities of barley. The river Slaney crosses the county from Newtown Barry to Wexford, receiving the Bann from the northward, and affords a perpetual variety of picturesque and romantic views among its wooded and winding banks. This river is navigable to Enniscorthy. The linen manufacture has made no progress in this county, but there is a manufacture of coarse woollens. The chief towns are Wexford, New Ross, and Enniscorthy, of which an account is

given under their names. Wexford has been notorious for the events which took place in it during the rebellion of 1798. In it the misguided populace was successful for some time, and the massacres at Scullabogue, and at the bridge of Wexford, afford a melancholy proof of what may be expected from an ignorant and almost barbarous peasantry, when they have the ascendancy. Their leaders were unable to controul them, and if the king's troops had not been successful, there would have been no bounds to their exterminating phrensy. Before the Union, Wexford had eighteen members, but these have been reduced to four, two for the county, and one each for the towns of Wexford and New Ross. Beaufort.

WEXFORD, a sea-port and post-town, and also the assize town of the county of the same name, in Ireland, at the mouth of the river Slaney. It was originally built by the Danes, who named it Wexford, and it was formerly considered a place of strength, being enclosed by very thick walls, some of which are still remaining. There are some handsome buildings; on the site of the old castle the barracks are erected, commanding an extensive view of the harbour. The church, situated in the main street, is an elegant modern structure. The market and court-house are likewise new edifices; but the chief ornament of Wexford is its wooden bridge, thrown over an arm of the sea, 2100 feet long, where insurmountable difficulties baffled all efforts to form a stone bridge. This bridge is a favourite promenade, and is as delightfully calculated for a pleasant recreation, as it constitutes an useful communication. The harbour, though spacious, is shallow, and formed by two necks of land, between which there is an entrance about half a mile broad, which was formerly defended by two forts, erected at the extremity of each isthmus. The mouth of the harbour is choked with a bar, and therefore no vessel drawing more than twelve feet water can pass to the town. Provisions of all kinds are very plentiful and cheap here, particularly the finest wild fowl. The chief export is corn, principally barley and malt. Wexford was taken from the Danes by the English invaders, after a siege of four days, in 1170; it was besieged and stormed by Cromwell in 1649; and on being evacuated by the king's troops, it was taken possession of by the rebels in 1798. The shocking murder of the loyal inhabitants, when 97 unoffending victims suffered at the bridge, has been already alluded to. There are seven parishes, but they are all united, and have only one church in common. Wexford is 67 miles S. by W. from Dublin. Carlisle. Traveller's Guide.

WEXIO, a town of Sweden, in the province of Smaland, situated on the Helga lake: the see of a bishop, and residence of the provincial governor; 46 miles N.N.W. of Carlscrona. N. lat. $56^{\circ} 52'$. E. long. $14^{\circ} 44'$.

WEY, a river of England, which runs into the Thames at Weybridge. This river is made navigable to Guildford and Godalmin, and a canal has lately been made from it to Basingstoke, in Hampshire.—Also, a river of England, which runs into the sea at Weymouth.

WEY. See WEIGH.

WEYBER, in *Geography*, a lake of Bavaria; 3 miles W.N.W. of Kempten.

WEYBRIDGE, a considerable village in the hundred of Elmbridge, and county of Surrey, England, is situated on the river Wey, whence it derives its name, not far from its conflux with the Thames, at the distance of 12 miles N.E. by N. from Guildford, and 20 miles S.W. by W. from London. It contains some respectable houses, among which is a large edifice, called Holstein-house, from having

been the residence of a prince of Holstein, when on a visit to England; it has for some years been used as a printing-office. The church is a small, but neat structure, having a nave and south aisle, at the west end of which is the vault of the earl of Portmore's family, built up about four feet above the level of the pavement, inclosed with iron rails, but without any inscription. The population return of the year 1811 states the parish of Weybridge to contain 167 houses, and 918 inhabitants.

In this parish is Oatlands, the seat of his royal highness the duke of York. This domain came into the possession of Henry VIII. by an exchange with the family of Rede, for the manor of Tandridge, in the same county. It was settled by Charles I. on his queen Henrietta Maria for her life; and their youngest son, called Henry of Oatlands, was born here. At the Restoration the queen dowager was again put in possession of the estate; and after her death Charles II. granted it to the earl of St. Alban's. In the next century it descended to the earl of Lincoln, afterwards duke of Newcastle, who fixed his residence here, enlarged the park, and made considerable plantations. In the park is a large piece of water, formed by springs which rise in it. Between the house and garden is a grotto, divided into three apartments, in one of which is a bath, supplied by a small spring, dripping through the rock; at the end of it is a copy of the Venus de Medicis, as if going to bathe.

The duke of York purchased this estate of the duke of Newcastle, together with the manors and parks of Byfleet and Weybridge, which he held by lease from the crown. In 1800 two acts were passed for inclosing the common fields and wastes, under which the duke obtained by allotments and purchases about 1000 acres of the waste, so that the domain now comprises about 3000 acres. The mansion was burned down while the duke was in Flanders, in 1793. The present house was then erected, from designs by Mr. John Carter; and in 1804 an act was passed for granting to the duke so much of this estate as was held of the crown.

In a small park in this vicinity is Ham, an old mansion, formerly the residence of the countess of Dorchester, mistress of James II. It is now uninhabited, and in a ruinous condition. Near it are many large cedars; one, in particular, measures, at five feet from the ground, about thirteen feet in circumference, and runs up straight to a great height.—*History and Antiquities of Surrey*. By the Rev. John Manning, and William Bray, esq. 3 vols. folio. *Beauties of England and Wales*, vol. xiv. Surrey. By F. Shoberl.

WEYBRIDGE, a township of the state of Vermont, in the county of Addison, separated from Newhaven by the Otter Creek, containing 750 inhabitants.

WEYDA, a town of Saxony, in the circle of Neustadt, on the Elster; 11 miles E.N.E. of Neustadt. N. lat. $50^{\circ} 42'$. E. long. $12^{\circ} 1'$.—Also, a river of Saxony, which runs into the Elster, 2 miles N. of Weyda.

WEYDEN. See WEIDEN.

WEYDENAU, a town of Silesia, in the principality of Neisse; 8 miles S.W. of Neisse. N. lat. $50^{\circ} 12'$. E. long. $17^{\circ} 2'$.

WEYDENEN, a town of Prussian Lithuania; 3 miles W.S.W. of Pilkallen.

WEYDENHAYN, a town of Saxony, in the margravate of Meissen; 7 miles W. of Torgau.

WEYER, a town of Austria; 2 miles N.E. of Gmunden.—Also, a town of the duchy of Stiria; 6 miles S. of Pruck.

WEYEREN, a town of Austria; 6 miles W. of Gmunden.

WEYERS,

WEYERS, a town of Westphalia, in the bishopric of Fulda; 8 miles E.S.E. of Fulda.

WEYERSHEIM, a town of France, in the department of the Lower Rhine; 6 miles S. of Haguenau.

WEYHER, a town of Austria; 6 miles W. of Bavarian Waidhoven.

WEYHILL, a village of England, in the county of Hants, celebrated for the great annual fair held here for the sale of sheep, hops, &c.; 3 miles W. of Andover.

WEYL, or WYL, a town of Switzerland, belonging to the abbey of St. Gal, and principal place of a bailiwick; 14 miles S.S.W. of Constance.

WEYLANOO, a town of Hindoostan, in Guzerat, on the coast; 20 miles S.E. of Puttan Sumnaut.

WEYMOUTH, or WAXMOUTH, a borough and market-town in the hundred of Uggescombe, Dorchester division of the county of Dorset, England, is situated on the southern coast of England, at the extremity of a beautiful bay, which forms nearly a semicircle, making a sweep of about two miles. The town is 8 miles S. by W. distant from Dorchester, and 128 miles S.W. by W. from London. It received its name from the mouth of the little river Wey, near which it stands, and communicates with Melcombe Regis, to which it is united by a bridge erected in 1770. That the site of Weymouth was known to the Romans is probable from several circumstances; and Mr. Baxter supposes it to have been the Clavinio, which is mentioned in the anonymous Ravennas. In the Saxon ages, however, it is expressly named in a Saxon charter still extant, by which king Ethelred gave a certain portion of land, called by the inhabitants Weymouth (or Wick), near the isle of Portland, to his faithful minister Atere. In the reign of Edward III. the town had become of some importance, the inhabitants being ordered, together with those of Melcombe and Lyme, to send a certain quota of ships for the king's expedition to Gascony. In the 21st year of that reign, Weymouth (for Melcombe is not mentioned, though perhaps included) furnished the king with 20 ships, and 264 mariners, at the siege of Calais, according to the roll of his fleet preserved in a manuscript in the Cottonian Library. In the year 1471, Margaret of Anjou, with her son, prince Edward, landed here from France, in order to restore her husband to the throne. In 1507, king Philip of Castile, with his queen, were driven on this coast, and having run into the port, were detained by sir Thomas Trenchard, till an interview took place between the English and Spanish monarchs, from which the former derived some advantages. In 1588, Weymouth contributed six ships to oppose the Armada, one of which was of 120 tons burthen. During the civil war of Charles I., this town was alternately garrisoned and besieged by the king, and by the parliament's forces. In 1649 the corporation petitioned parliament for an indemnification for the losses they had sustained in the war, and a relief from the burthen of maintaining the garrison; but their request does not appear to have been granted, as a letter was soon afterwards received concerning the "refractoriness of the magistrates." The manors of Portland and Wike, with the ports of *Waimuth* and Melcombe, and the liberties attached to them, were granted by charter of Henry I. to the monks of St. Swithun, Winton; and Henry II. confirmed the port of *Waimue* and the whole land of Melcombe to that establishment, with additional privileges. Weymouth and Melcombe are (as has been observed under MELCOMBE *Regis*) so frequently joined in descents and ancient grants, that some difficulty occurs in separating them with precision. Weymouth is the more ancient borough; though neither sent members to parlia-

ment till the reign of Edward II., since which time each of them returned two. Melcombe, being part of the demesne of the crown, and possessing some peculiar privileges, is principally noticed in succeeding charters. The rivalship which subsisted for centuries between the two boroughs arose, in the reign of Elizabeth, to such a height, that it was judged expedient to unite them; and an act was passed in her 13th year (afterwards confirmed by James I.), by which they were incorporated, and directed hereafter to be called "The united Town and Borough of Weymouth and Melcombe Regis;" the government being vested in a mayor, recorder, two bailiffs, an indefinite number of aldermen, and twenty-four capital burgesses: and they now possess, as one borough, the peculiar right, with the metropolis, of sending four members to parliament. The representatives are elected by the freeholders of Weymouth or Melcombe, whether inhabitants or otherwise. The number of voters is about two hundred. These electors have also votes for the county members. Leland says, "The townlet of Weymouth lyeth strait agayn Milton (Melcombe) on the other side of the haven, and at this place the water of the haven is but a smaule brede, and the trajectus is by a bote or a rope bent over the haven; so that in the ferry-bote they use no oars. Waighmouth has certain liberties and priviledges, but there is no mair in it. Ther is a kay and wharf for shippes. By this town on a hill is a chapel of ease. The parochie church is a mil off." The chapel mentioned by Leland was remarkable for its elevated situation; having, according to Coker's survey of this county, an ascent of eighty stone steps. It was of considerable antiquity, as appears by a patent of Henry VI., granting a licence to found a guild in the chapel of St. Nicholas, in the borough of Weymouth, by the name of the master and wardens of the fraternity or guild of St. George, in Weymouth. This chapel was demolished in the civil war: the site is still called Chapel Hays, and is now used as a bowling-green. Weymouth, since the time of Elizabeth, had, from a variety of causes, been gradually going to decay. The removal of the wool-staple to Poole, the loss of the Newfoundland trade, the havoc made by the civil wars, damages by fire, want of public spirit, and other circumstances, had concurred to produce this effect; and till it began to acquire celebrity as a watering place, it was little more than an inconsiderable fishing-town. The late Ralph Allen, esq. of Bath, about the year 1763, first contributed to bring Weymouth into repute. Having received great benefit from bathing there, he proclaimed its salubrity to the extensive circle of his acquaintance; and his encomium being exceeded by the real beauties of the situation, it soon began to be the resort of the first company from all parts of the kingdom. The reputation thus acquired was extended by the late duke of Gloucester, who, having derived considerable advantage himself, provided a residence for the accommodation of the royal family; and their majesties, accompanied by the three elder princesses, in the year 1789, made their first visit to this place. His majesty experienced its beneficial effects, and became so attached to the spot, that he has repeatedly honoured it with his presence. The advantages arising from these visits have proved of the greatest consequence to the town, which has rapidly augmented in size and importance, from the vast concourse of people by which it is now frequented. The chief objects of curiosity to strangers, are the Esplanade and the Bay. The Esplanade, a fine level piece of sand, which, but a short time ago, was nothing but a receptacle for all the rubbish of the town, is now converted into one of the most charming promenades in England, and adorned by a range of handsome edifices.

This public walk is half a mile in length, and about thirty feet in breadth. The bay, where the company bathe, makes a semicircular sweep of nearly two miles, and is protected from winds by the surrounding hills, which render the sea perfectly secure. As soon as Weymouth became a place of fashionable resort, the expediency of public amusements was perceived; and Mr. Sproule of Bath offered proposals for erecting a set of assembly-rooms, with an hotel, and other necessary appendages. The propositions were acceded to; and about the year 1772, a building, 600 feet in length, and 250 in width, was erected on a vacant spot adjoining the town, at the expence of 6000*l.*, which was defrayed by subscriptions in shares of 100*l.* each. The Royal Assembly Room is a lofty, light, and spacious building, in which upwards of an hundred couples may dance with ease and pleasure. The theatre has been recently fitted up in a style of elegance that does equal credit to the manager and the architect. The boxes are capable of containing 300 spectators; and the mode in which they are decorated is little inferior to the London theatres. On the quay is a most convenient hot salt-water bath. The bridge has been rebuilt in the Chinese style. The church is a low structure, occupying the site of an ancient chapel belonging to the church at Radipole, of which parish this was originally a part, but in the reign of James I. was made a separate jurisdiction; within it is a fine altar-piece, representing the Last Supper, for which sir James Thornhill, who executed and presented it to the town, is said to have refused 700*l.* East of the church are some buildings that are connected with a Dominican priory, founded here about the commencement of the fifteenth century. These are now parcelled out in tenements; and the chapel belonging to the priory is used as a malt-house. The Quakers and Independants have each a meeting-house here. The number of houses in Weymouth, as returned under the population act of 1811, was 447; of inhabitants 1747. Markets are held on Tuesday and Friday; and here are three annual fairs.

Several small forts have at various periods been erected to defend the town and harbour. On a high cliff, about a mile from the town, are the ruins of Sandisfoot castle, a fortress erected by Henry VIII. about the year 1539, when he expected the Papal see to excite an invasion of this country. Leland denominates it, "a right goodly and warlike castle, having one open barbican." Its form was a parallelogram, the greatest length running from north to south. The walls, which were mostly cased with squared Portland stone, were lofty and very strong: in some places, the thickness was not less than seven yards.—Hutchin's History of Dorsetshire, 3 vols. folio. Beauties of England and Wales, vol. iv. Dorsetshire. By J. Britton, and E. W. Brayley, 1804.

WEYMOUTH, a town of New Jersey, in the county of Gloucester, containing 1029 inhabitants.

WEYMOUTH, or WASSAGUSSET, a town of the state of Massachusetts, in the county of Norfolk, containing 1889 inhabitants. This is said to be one of the oldest towns in the state. It lies on the coast, and has some small vessels employed in fishing. The cheese made in its environs is much esteemed; 5 miles S. of Boston.

WEYMOUTH Bay, a bay on the N.E. coast of New Holland, to the N.W. of Cape Weymouth.

WEYPERT, a town of Bohemia, in the circle of Saatz; 25 miles N.W. of Saatz. N. lat. 50° 25'. E. long. 13°.

WEYS, a river of Austria, which runs into the Danube, a little to the E. of Ips.

WEZE, a river of France, which runs into the Meuse at Liege.

WHALE, in *Astronomy*, one of the constellations. See CETUS.

WHALE, *Cete*, in the Linnæan system of *Zoology*, the seventh order in the class of *mammalia*. For the characters and distribution of this order, see CETE.

For the discriminating characters of the genus of *balæna*, or whale, and a general account of its species, see BALÆNA.

The common whale, or *balæna mysticetus* of Linnæus, with its variations, &c. is described under the article MYSTICETUS. Aristotle is said to have given it the name of *mysticetus*, *μυστικητος*, or bearded whale, from its having in its mouth hairs instead of teeth.

In old time the whale seems never to have been taken on our coasts, but when it was accidentally flung on shore: it was then deemed a *royal fish*; and the king and queen divided the spoil; the king asserting his right to the head, and the queen to the tail. The reason of this whimsical division, as assigned by our ancient records, was to furnish the queen's wardrobe with whale-bone.

The anatomy of the bones of the whale has been so little understood, that there have been many very great errors in regard to such of them as have been at times found fossil, or buried in the earth among the teeth of elephants, and the remains of testaceous and other animals. The most frequent and most ridiculous of all the wrong opinions about these, is their having originally belonged to creatures of the human species; yet many, even among the more intelligent part of the world, have taken them for the remains of giants. The vertebræ of a whale have been mistaken for those of a giant, and a part of its fins for a hand, and so of the rest. While the world, more ready to spread the marvel, than to enquire into the truth, have made computations of the height of the man to whom bones of that size must have belonged, and from their proportion in regard to those of the common human size, have found the giant who possessed them must have been 90 or 100 feet high; much less pains in comparative anatomy would have taught them, that they never could have belonged to any human body at all. Mem. Acad. Par. 1727.

WHALE, *Beaked*, *Bottle-head*, or *Nebbe-haul*, *Balæna Roftrata*, the small whale, with taper snout, and adipose back fin, or with very long and acute beak or snout. The head, upper part of the back, fins, and tail, are of a dark or blueish-brown; and the sides and abdomen are of a beautiful white, with a slight tinge of pale rose or flesh colour; and marked for more than half the length of the animal by numerous longitudinal plaits or furrows: the eyes are small, as is also the head, and the snout is more elongated than in any other species, tapering gradually to the extremity, which is slightly pointed; the back fin is small, and situated at no great distance from the tail; the pectoral fins are small and narrow, and the tail is divided into two longish and pointed lobes. This is of a more elegant form than those of the larger species. These fish sometimes, but rarely, grow to the length of twenty-five feet; they make little noise in blowing, are very tame, come very near the ships, and will accompany them a great way.

WHALE, *Fin-back*, *Balæna Physalus* of Linnæus, called also *fin-fish*. See PHYSALUS.

WHALE, *Pike-headed*, *Balæna Boops* of Linnæus, is a species which takes its name from the shape of its nose, which is narrower and sharper-pointed than that of other whales. The length of one taken on the coast of Scotland, observed by sir Robert Sibbald, was forty-six feet, and its greatest circumference twenty; but it sometimes exceeds this length. From the skinny flap at the root of the tongue, as well as from

from the intestines, the Greenlanders prepare windows. See **BOOPS**.

WHALE, *Round-lipped*, or *Broad-nosed*, or *Under-jawed*, *Balæna Musculus* of Linnæus, is characterized by having the lower lip broader than the upper, and of a semicircular form. See **MUSCULUS**.

WHALE, *Bunched*, *Balæna Gibbosa* of Linnæus, with one or more gibbous excrescences on the back, and without dorsal fins: the *Knottensfisch* oder *Knobbelfisch* of Anderfon and Crantz. This species is a native of the Northern seas, and though not much known, is said to be of the same general form with the great whale, but of smaller size, and having its back furnished with one or more tubercles. The variety with a single tubercle is found about the coasts of New England; the other with six tubercles along the back is supposed to swarm about the coasts of Greenland. Their whale-bone is said to be of a pale or whitish colour.

WHALE *Spermaceti*. See **CACHALOT**, **PHYSETER**, and **SPERMACETI**.

See on the subjects of the preceding articles, Pontopidan's Nat. Hist. of Norway, vol. ii. p. 118, &c. Crantz's Hist. of Greenland, vol. i. p. 106, &c. Pennant's Brit. Zool. vol. iii. p. 50, &c. Phil. Trans. abr. vol. viii. p. 424, &c. Shaw's Zoology, vol. ii.

WHALE-Blubber, in *Agriculture*, the fat oily refuse matter left in making the oil from that fish. It is a material which has been used as a manure in some cases with success, especially when employed in mixture with clayey loam, sandy loam, or any other common earthy or mouldy substances. These matters should be blended together in such a manner, it is said by the writer of the "Elements of Agricultural Chemistry," as to expose a large surface to the action of the air, the oxygen of which produces soluble matter from them. It is observed, too, that lord Somerville made use of this oily substance with great success on his farm, in the county of Surrey; in which case it was made into a large heap with soil, and retained its powers of fertilizing for several successive years.

It is noticed, that carbon and hydrogen abounding so much in this as well as other oily substances, fully account for their effects; and that their durability is easily explained from the very gradual manner in which they change by the action of the air and water on them, as must obviously be the case.

This fatty material, in this sort of union with earthy matters, may consequently be a very beneficial application in many cases of tillage-land, especially where the superficial bed of mould or soil is rather of the thin kind. It may also be very useful as a top-dressing to grass-land, particularly where the sward is thin, tender, and not well set with grassy herbage, as tending not only to promote the growth of the crops, but the closeness and firmness of the surface swardly covering. See **MANURE**, and **OIL Compost**.

It should therefore be preserved and procured as much as possible for these uses and applications.

WHALE-Bone, a commodity procured from the whiskers of the whale, used as a stiffening in stays, fans, buxks, screens, &c. See **WHALE supra**.

Frederick Martens has particularly described the whale-bone and the method of procuring it in his "Voyage to Spitzbergen." Within the mouth of the fish is the whale-bone, hairy as a horse's hair, and hanging down from both sides, all about his tongue. In some whales the whale-bone is bent like a scymitar, and in others like a half-moon. The smallest whale-bone is before in his mouth, and behind towards his throat; and the middlemost is the largest and the longest, being sometimes about two or three men's length. On one

side, all in a row, there are 250 pieces of whale-bone, and as many on the other, containing in all 500; and there are still many more, for the cutters let the least of all remain, because they cannot easily come at it to cut it out, on account of the meeting of the two lips, where the space is very narrow. The whale-bone is in a flat row, one piece by the other, somewhat bending within, and towards the lips every where like a half-moon. It is broad at the top, where it sticks fast to the upper lip, every where overgrown with hard white sinews towards the root, so that between two pieces of whale-bone you may put your hand. These white sinews are of an agreeable smell, break very easily, and may be boiled and eaten. Where the whale-bone is the broadest, as underneath by the root, there groweth small whale-bone, the other being greater. The small whale-bone, as Mr. Martens supposes, does not grow bigger; from one end to the other it is equally thick, and full of long jacks, like horse's hair. The whale-bone is underneath narrow and pointed, and all overgrown with hair, that it may not hurt that which is young; but without the whale-bone has a cavity, for it is turned like a gutter, in which the water runs, where it lies the one over the other, like the shields or plates of craw-fish, or the pantiles of an house, that lie one over the other; for otherwise it might easily wound or hurt the under lip. To cut the whale-bone out is a particular operation, and many iron tools are used for this purpose. Some whale-bone is of a brown, black, or yellow colour, with streaks of several colours. The whale-bones of some whales are blue and light-blue, which latter are supposed to come from young whales.

WHALE-Fins, a name improperly given to whale-bone.

WHALE-Fishery. See **FISHERY**.

WHALE OIL. See **OIL**.

Mr. Parkes (Essays, vol. i.) observes, that the dealer in Greenland whale oil might also increase the profits of his trade very much, by preparing his oil for sale when the weather is suitable for the operation. This kind of oil is always purified by passing it through large flannel bags, which retain the impurities, and suffer the finer parts to percolate through them. When the oil has undergone this treatment, it is called *bagged* oil, and is then deemed fit for sale. At a low temperature, a considerable quantity even of this latter kind would concrete, and might be separated by similar means; whereas in a warm atmosphere this dissolves, and, being less inflammable, very much injures the oil for burning.

By proper attention to this circumstance, all the oil which is designed for burning might be very much improved, and the portion thus separated from it, would be worth more to the soap manufacturer for making yellow soap, than similar oil which had not undergone this process.

This intelligent chemist conceives, that an oil-merchant would do well always to bag different oils in different seasons; though many experiments might be necessary before it could be ascertained what was the exact temperature at which the respective kinds would most copiously deposit this feculence. After observing that in several parts of Germany, and particularly in the neighbourhood of Gottenburgh, ammonia is prepared from the dregs which remain after the expression of train-oil, he suggests that whale-blubber might be employed for the distillation of ammonia. Madder, he says, might be devised for correcting its offensive smell, and rendering it very productive of volatile alkali. See **AMMONIA**.

WHALE Bank, in *Geography*, a fishing-bank on the coast of Newfoundland, 60 miles long, and 21 wide; 90 miles S. of Cape Mary. N. lat. 45°. W. long. 53° 50'.

WHALE Cove, a bay of the Atlantic, on the north coast of the island of Manan, near the coast of Maine.

WHALE Fish Island, an island on the coast of Guiana, at the mouth of the river Essequibo.

WHALE Island, a small island in the North sea. N. lat. $69^{\circ} 14'$. W. long. 134° .—Also, a small island near the north-west coast of Borneo. N. lat. $4^{\circ} 10'$. E. long. $112^{\circ} 21'$.

WHALE Islands, small islands in Portsmouth harbour. N. lat. $50^{\circ} 48'$. W. long. $1^{\circ} 5'$.

WHALE Point, the south-east cape of an island in the straits of Magellan; 6 miles S.S.W. of Passage Point.

WHALE Rock, an under-water rock at the entrance of the Bay of Islands, on which the Endeavour struck in 1769; 4 miles S.E. of Point Pocock.

WHALE Sound, a channel in the straits of Magellan, between an island and the coast of Terra del Fuego.

WHALFIRTH VOE, a bay on the west coast of the island of Yell. N. lat. $60^{\circ} 58'$. W. long. $1^{\circ} 25'$.

WHAME, in *Natural History*, the name given by the people of some parts of England to the burrel-fly, or wringle-tail, a species of bee-fly very troublesome to horses.

WHANG-HO, in *Geography*. See HOANG-HO.

WHAPLODE, a township of Lincolnshire; 2 miles S. of Holbeach.

WHAPPING'S CREEK. See WAPPING'S Creek.

WHARF, a perpendicular building of wood or stone, raised on the shore of a road or harbour, for the convenience of landing or discharging a vessel, by means of cranes, tackles, capsterns, &c. See *Artificial PORTS*.

The fee paid for the landing of goods on a wharf, or for shipping them off, is called *wharfage*. And the person who has the oversight or direction of the wharf, receives wharfage, &c. is called the *wharfinger*.

There are two legal denominations of wharfs, *viz.* legal quays and sufferance wharfs.

Legal quays are certain wharfs in all sea-ports, at which all goods are required, by the 1 Eliz. c. 11., to be landed and shipped (except at Hull); and they were set out for that purpose by commission out of the court of exchequer, in the reign of Charles II. and subsequent princes. Others have been legalized by act of parliament; as the London docks, by 39 & 40 Geo. III. c. 47.; West India docks, by 39 & 40 Geo. III. c. 69. and 42 Geo. III. c. 113; East India docks, by 43 Geo. III. c. 126. and 46 Geo. III. c. 113. (See *DOCKS*.) Hull, by 14 Geo. III. c. 56. and 42 Geo. III. c. 191.; Milford, by 30 Geo. III. c. 55.; Bristol, by 48 Geo. III. c. 11.

In some ports, certain wharfs are deemed to be legal quays by immemorial practice, though not set out by commission, or legalized by act of parliament; such as Chepstow, Gloucester, &c.

Sufferance wharfs are places where certain goods may be landed and shipped; such as hemp, flax, raff, and other bulky goods; likewise goods carried coastwise, in Great Britain, by special sufferance granted by the crown for that purpose.

The constituting limits to the ports and legal quays is part of the royal prerogative. Lord Hale's Treatise. *Vide* Hargrave's Tracts.

WHARF also, in a canal, denotes that wider part of it where boats lie while loading or unloading.

WHARFAGE, in *Commerce*, certain rates paid for landing and shipping goods from the quays.

WHARFE, or **WHERFE**, in *Geography*, a river of England, in the county of York, which runs into the Ouse, 7 miles below York.

WHARFINGER, the proprietor or farmer of the quays where goods are shipped and landed.

By the 26 Geo. III. c. 40. no goods entitled to drawback or bounty on exportation are to be shipped in Great Britain, but by wharfingers licensed by the commissioners of the customs; and in docked lighters. And they are to give bonds not to be concerned in illegally landing, relanding, or shipping goods. They are also liable to certain penalties at conniving or knowing of any fraudulent transaction, or landing goods at improper places and times, by 1 Eliz. c. 11., and 13 & 14 Cha. II. c. 11.

WHARTON, HENRY, in *Biography*, an English divine of the Established Church, was born in 1664, at Worstead, in Norfolk, where his father was vicar; and in his sixteenth year admitted a pensioner of Gonville and Caius college at Cambridge, where he assiduously pursued the study of various branches of literature, and particularly of mathematics, under Isaac Newton, Lucasian professor. After taking the degree of B.A. with great reputation, he assisted Dr. Cave in his "Historia Literaria," contributing almost the whole of the appendix of the three last centuries. In 1687 he took orders, and his degree of M.A. in the following year. He had various literary occupations, chiefly in writing or editing treatises against Popery; until he took priest's orders, when he was presented first to the vicarage of Minster in the isle of Thanet, and in 1689 to the rectory of Chartham. By the advice of Dr. Lloyd, bishop of St. Asaph, he undertook the work which gave some celebrity to his name, intitled "Anglia Sacra, sive Collectio Historiarum, partim antiquitus, partim recentior Scripturarum, de Archiepiscopis et Episcopis Angliæ à prima Fidei Christianæ susceptione ad Annum 1540," 2 vols. fol. London, 1691. An additional part was published after his death in 1695, under the title of "Historia de Episcopis et Decanis Londinensibus; necnon de Episcopis et Decanis Asslavenfisibus (St. Asaph); à prima Sedis utriusque Fundatione ad Annum 1540," 8vo. The author's "Anglia Sacra" was the result of great industry and labour, and evinces the author's zeal for the church to which he belonged; but it is chargeable with incorrectness. In 1692 he published "A Defence of Pluralities;" in the following year he edited some ancient theological pieces; and, under the name of Anthony Harmer, published "A Specimen of some Errors and Defects in the History of the Reformation of the Church of England, by Gilbert Burnet, D.D.," a work which excited the indignation of the author, and caused him to mention Wharton with asperity in the introduction to the third volume of that work. The last publication of Wharton was "The History of the Troubles and Trial of Archbishop Laud;" to which were added Laud's diary, and some other pieces. He also edited the Life of Cardinal Pole, by Bacatelli, together with some animadversions on Strype's Memorials of Archbishop Cranmer. Although his constitution was strong, he closed his life, in consequence of intense application, somewhat prematurely, in March 1694-5, in the 31st year of his age, leaving several MSS., some of which were afterwards printed, as also two volumes of sermons. He was interred in Westminster-abbey. *Biog. Brit.*

WHARTON, PHILIP, *Duke of*, the son of the marquis of Wharton, who was a firm supporter of the Revolution and Hanover succession, was born in 1699; and after having exhibited talents which commanded notice, when he was 13 or 14 years of age, in the course of his education under domestic tutors, contracted a premature marriage with the daughter of major-general Holmes, and thus disappointed his father's views, and hastened his death in 1715. In the beginning of 1716, Philip set out on his travels, proposing to finish his education at Geneva; but the young marquis, having contracted a taste for gaiety and expence,

was disgusted with the manners of that place, and leaving his governor there, proceeded to Lyons, and wrote to the Pretender at Avignon, accompanying his letter with the present of a fine horse. The Pretender was highly gratified, and receiving the marquis at his court, decorated him with the title of the duke of Northumberland. At Paris he paid his respects to the dowager-queen of James II., and received notice and good advice from the English ambassador, lord Stair. About the end of 1716 he returned to England, and going over to Ireland, where he possessed a peerage, he was admitted to take his seat in the house of lords of that kingdom. Here, deserting the principles and connection which he had lately formed, he defended the established government with all the powers of his reasoning and eloquence; in consequence of which he was advanced to a dukedom, by the style of duke of Wharton, in the county of Westmoreland. Upon coming to age, he took his seat in the English house of lords, where he distinguished himself by an abandonment of his lately avowed principles, in the defence of bishop Atterbury; and he also published a virulent opposition paper, intitled "The True Briton." But such was his boundless extravagance, that his estate was vested, by a decree of chancery, in the hands of trustees, who allowed him an annuity of 1200*l*. Having only this pittance, he determined to live abroad, and to enter into the service of the Pretender. Having visited Vienna and Madrid, he formed an acquaintance at the latter place with a young lady of Irish extraction, who was maid of honour to the queen of Spain, and married her; his duchess having died in 1726, without leaving any issue. From Rome, where he appeared under the title of the duke of Northumberland, and decorated with a blue ribband and garter, he returned to Spain, and obtained permission from the king to go as a volunteer to Gibraltar, which was then under siege by the Spaniards. When this siege broke up, he visited the Spanish court, and was nominated by the king "colonel-aggregate" of one of the Irish regiments. Discouraged in his wishes to be actively employed in the service of the Pretender, he went to Paris, and with singular effrontery paid a public visit to the English ambassador, Horace Walpole; informing him, upon taking leave, that he was going to dine with the bishop of Rochester, though it had been made criminal to hold any communication with that exiled person. At this time a bill of indictment for high treason was preferred against him in England, for having appeared in arms against his majesty's fortresses at Gibraltar; but a wish to reclaim him induced sir Robert Walpole to send two friends to offer him his re-establishment and the possession of his estate, if he would only sue for pardon. This he refused to do, consenting only to accept a pardon if freely granted him. His allowance from home was discontinued, and he was overwhelmed with debts abroad. From Rouen, where he had for some time resided, he removed to Paris, living meanly, and providing for himself by various dishonourable expedients. Having obtained a small sum, when all his resources had failed, he took his duchess with him, and went by water to Bilboa. From thence he proceeded to join his regiment, subjecting his duchess to extreme distress, in which she was occasionally relieved by the bounty of the duke of Ormond, who was himself an exile. In 1730 his health declined, and he amused himself in composing a tragedy, on the story of Mary queen of Scots; but his end was approaching. In his way to a mineral spring, in the mountains of Catalonia, where he had once obtained relief, he was obliged to stop at a small village, when his condition was so pitiably destitute, that the fathers of a Bernardine convent took compassion upon him, and brought him to their house, where by atten-

tion and cordials his life was prolonged for about a week. At length, without a friend or acquaintance to close his eyes, having performed the last duties of penitent devotion, he expired on May 31, 1731, in the 32d year of his age, and was interred the next day after the manner of a poor monk. Pope has recorded his character, in the first epistle of his *Moral Essays*, in the following beautiful lines:

" Thus with each gift of nature and of art,
And wanting nothing but an honest heart;
Grown all to all, from no one vice exempt,
And most contemptible to shun contempt;
His passion still, to covet general praise;
His life, to forfeit it a thousand ways;
A constant bounty which no friend has made;
An angel tongue which no man can persuade;
A fool, with more of wit than half mankind;
Too rash for thought, for action too refin'd;
A tyrant to the wife his heart approves;
A rebel to the very king he loves;
He dies, sad outcast of each church and state,
And, harder still! flagitious, yet not great."

Wharton was one of the warmest patrons of Young, who dedicated to him his most celebrated tragedy "The Revenge," and gave him the credit of having suggested the most beautiful incident in that composition. *Biog. Brit. Pope's Works. Johnson's Lives of the Poets.*

WHARTON, THOMAS, a physician and anatomist, was born in Yorkshire, in 1610, and educated at Pembroke-hall, Cambridge. Before the civil wars he resided in Trinity college, Oxford, as private tutor to a natural son of lord Sunderland. Upon the commencement of the war, he removed to London, and engaged in the practice of physic. After the surrender of Oxford to the parliament in 1646, he returned to Trinity college, and was created M.D. by the recommendation of general Fairfax. Returning again to London, he became a member and censor of the college of physicians, and acquired considerable practice and reputation. In 1652 he read lectures before the college on the subject of the glands; but labouring, as other anatomists of that day did, under a scarcity of human subjects, he was under a necessity of availing himself of animal dissection. In his work, intitled "*Adenographia, five Glandularum totius Corporis Descriptio*," 1656, 8vo., his descriptions are almost wholly taken from brute animals, and therefore cannot stand the test of modern accuracy. Nevertheless he revived and improved the knowledge of the salivary ducts on the side of the tongue, to which he affixed his own name; and he furnishes useful observations on the diseases of the glands. He died in 1673. *Haller. Gen. Biog.*

WHARTON, in *Geography*, a township of Pennsylvania, with 922 inhabitants; 30 miles S. of Pittsburgh.

WHATLY, a town of Massachusetts, with 891 inhabitants; 10 miles N. of Northampton.

WHATOGA, a town of United America, in the Tennessee state; 40 miles S. of Knoxville.

WHEAT, in *Botany*. See TRITICUM.

WHEAT, in *Agriculture*, a well-known valuable grain, much cultivated and grown in many parts of this as well as most other countries, as being the principal sort of corn from which bread is made. It is not now well known from what country wheat was first introduced into this; but it has lately been suggested as probable, by sir Joseph Banks, in consequence of having a small paper of seeds, on which were written *Hill wheat*, put into his hands, the seeds contained in which were found to be scarcely larger than those of our wild grasses; though, when nicely examined, they perfectly

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perfectly resembled grains of wheat, and which on being sown in a garden very unexpectedly proved to be wheat of the spring kind, and the usual size, the grains of which being nearly, if not wholly, as large as those of the ordinary wheat of the above sort, that the packet and seeds came either from the peninsula, or from the hilly country, far within land from Bengal, as that province itself is a flat alluvial tract of land, entirely level. That as this hill wheat is, however, no doubt, it is supposed, known to some persons who are now either in India, or who have lately returned from thence into this country, it is certainly a matter of some importance to know what information they can give on the subject of it, especially whether this wheat be a cultivated, or a wild plant; as we shall, it is said, if the latter be the case, ascertain two of the greatest desiderata of cultivators; as those of the country where wheat grows spontaneously, and the nature of the grain in its original state, when unassisted by the fostering hand of man.

It is by no means improbable, from the nature and habits of wheat, that it may have come originally from the hilly country of the east, and been rendered hardy by time and cultivation in this and most other parts of the world.

Wheat is a kind of grain of which there are two different species, in cultivation as crops, in the climate of this country; as the common *smooth* or *polled* wheat, and the *cone rough* or *bearded* wheat. Of the first of these sorts, which is by much the most cultivated in this kingdom, as being the most suited to the nature and quality of the largest extent of the soils or lands in it, and as affording the finest kind of flour, there are numerous varieties that are differently preferred in different situations; and the latter species, which is often termed *riquet* wheat, and which has also several varieties that differ little except in the colour of the chaff and the form of the ears, though it does not afford the finest sort of flour, as yielding the largest quantity of produce on stiff moist clayey lands, and as being less subject to injury and disease from wetness on such soils, as well as less liable to lodge from its firmness of stem, is frequently cultivated and grown on such sorts of land.

It has been observed by an able and intelligent cultivator in the county of Kent, Mr. Boys, that the number of sorts of this grain is annually increasing by importation from foreign countries. But that the *old* sorts are the *brown* and *yellow lammas*, the *white straw*, *Fulham*, and the *white* or *egg-shell*. That the *brown lammas* was the kind chiefly cultivated in that county till within these twenty or thirty years; but that it has now given way to a variety of new kinds, as well as some of the other old sorts: experiment has, however, shewn it to be the least productive of the several sorts. It is the common *brown-strawed wheat* that grows with a long jointed ear, the chaff of a dark brown colour, the straw long and apt to fall, the hull or bran thin, the flour very white, and the corn mellow in grinding, for which reason it is esteemed by the millers as the best of the *old* sorts for their use; and that the *yellow lammas* resembles the *brown*, in every respect, except that the colour of the grain is of a yellow hue, and the chaff of a somewhat lighter colour than the others. A red lammas with a red straw, red ear, and red kernel, is noticed by Young as being reckoned by many farmers the best of all the sorts hitherto known, as yielding the finest and whitest flour. The first of these writers states, that the *white-strawed wheat* takes its name from the colour of its ear, and in other counties has the title of the *Kentish white straw*. That it sends out a greater number of stems from the stool or plant than the other sorts, and in that way is often a very thick crop on the land. That the straw is generally somewhat shorter than that of many

other sorts, and not quite so liable to fall in rainy seasons. That it is on these accounts much sown in the eastern parts of that county; but that from its dull colour, its having a thick bran, and often grinding very steeply, it is not much approved by the millers of the district. It is remarked, that the *Fulham* sort produces a white straw, which grows short and coarse; but that it is very productive, particularly on poor land: the grain is however coarse, and the bran thick, which circumstances render it the least valuable to the millers of any of the sorts described above. And that the *white* or *egg-shell* wheat is known by its producing a white straw, a smooth white chaff, and very white grain: the bran of which is very thick, but the flour remarkably white. It works mellow in grinding, is very early ripe, and so free in the ear as to blow out in windy weather, which is a disadvantage.

It is noticed, that of the *new* sorts of wheat in that county, as the *hoary white*, the *nonpareil*, the *pilbeam*, the *square ear*, the *hoary brown*, and the *hoary white*, called by some the *velvet-eared*, the last is by far the most valuable, as being very productive, and the best for the miller's use. It has the straw white and short, the chaff covered with a thick fine down, somewhat of a brownish hue; the grain remarkably small, and of a dull white colour, the bran very thin, so that the grain in some cases is almost transparent when held up to the light. It grinds very mellow, and makes a beautiful fine white flour. But from the quantity of the down upon the chaff, and its small ears binding up very close in the sheaf, it is apt in a rainy season to vegetate too freely in the field; on which account it is not so proper to cultivate in a moist climate, and in small inclosures that are not open to the influence of the sun and winds. That the *nonpareil* is a sort said to have been brought into this country from America: it has a bright straw, with a brown ear; and the grain is very white, large, and plump. It is very productive on all soils, thrashes very free, and yields in that operation the greater part of its chaff; thereby producing a great quantity of horse-meat. It grinds very mellow, and is well esteemed by the millers in most districts. And that the *pilbeam* is a brown wheat growing very stiff, and is generally thick on the land. The grain is small and plump, somewhat of a yellow-brown. It is accounted very productive on rich lands, and is a valuable kind to mix with others, but will not of itself make good bread, from its not fermenting or working properly in that operation. In regard to the *square-eared wheat*, that it is a very productive sort, but is apt to drop out in the field, before it is ripe, and in gales of wind, on which account it is not so much cultivated. And that the *hoary brown* is but lately introduced, consequently little known at present. And the *hoary white* sort, which has a white straw, ear, and grain, is in much the same situation. That the *Clarke-wheat*, which has a red blossom, chaff, and straw, but white grain, is much cultivated in Suffex. That the *hedge wheat* is also white and very productive. And that the *velvet wheat* is distinct from the hoary white, but is white, not weighty, yet affording much flour, being very thin in the skin.

There are also different varieties of cone or bearded wheat, a sort which is named from the form of the ear, as has been seen above. That of the *riquet wheat*, there are two sorts, the white and the brown, neither of which are much cultivated in Kent. They both ripen late in the season, and are so coarse and steeply, as to be unfit for making bread, unless mixed with a large proportion of a better sort of flour. They, however, produce very abundant crops on strong wet lands, as has been noticed. It is remarked, too, by Mr. Young, to be a productive sort on very poor, wet,

cold land, though a coarse grain, selling at an inferior price in the markets. And the bearded or rivet kind of wheat is likewise thought, by some cultivators, to be the most adapted to such kinds of rich lands as have been newly broken up, and where there may be danger of the crop lodging from too great luxuriance, as it possesses the property of a greater firmness of straw or stem than the common kinds, as suggested above.

The white and the red are the sorts the most esteemed in general among the polled kind; the former affording the whitest flour, but the latter has the greater produce in most cases.

It is observed, that of the several sorts of wheat that are in cultivation in the county of Suffex, the velvet-eared is preferred in the weald part of it, as having by much the thinnest skin: they there call it *stuffed*. It weighs on the average from fifty-nine to sixty pounds the bushel. It is said by the best judges that the *white stuff* on good land answers best, as being the most saleable: but that on poor land, subject to poppies, the strong-strawed sort that overpowers this weed should certainly be sown.

There is a sort of wheat that obtains much on the Down parts, which is what they call Clark wheat. It is not bearded; has a red blossom, red chaff, and red straw; white grain, as already seen; the sample coarse, being in price under the finest sorts. It is, however, a great yielder, and requires to be cut forward.

The *Chidham white* or hedge wheat is much in cultivation, being introduced by Mr. Woods of this district. Upon trial it is found to be a very fine sort: it is white, of a very fine berry, and remarkably long in the straw. It is now much grown in many of the southern as well as northern counties.

In the county of Essex, according to the Corrected Report on the Agriculture of that district, Mr. Kemp of Hedingham compared wheat from Italy, from Scotland, and from Dantzic; the last by far the best, and next the Scotch; but the Italian was full of smut in spite of every attention in brining and liming; and sowing it a second time with still more precaution, the result was the same.

About Burnham, some cultivate a sort of wheat from Italy, which they approve of much; the straw is remarkably stout and stiff. They cultivate also a sort called the *Sopsodite*; red grain, red chaff, and purple straw; this is a very good sort. The Taunton Dean, too, is beautiful, but will not bear rough weather. For two years past the Hamburgh white, with white grain, and white chaff, has been a fashionable sort; the white American sort is also used.

The sorts most usually sown about Kelvedon are the *burrel red chaff*, and red grain; and the *white rough*; white chaff, and white grain, the chaff rough: this sort stands the weather well, and does not shell easily; but is rather difficult to thrash. About Langenhoe they generally sow white wheat on heavy land, and rarely rivets, *rough chaff*, *York white*, also *American red*. Some other of the above sorts are likewise in use.

It is remarked that a few years ago, as a person at Bradfield was walking through his wheat-fields when the corn was in full blossom, he was struck with the variety of hues, or colours, which the blossoms assumed: at first he conceived it might be owing to the different stages of forwardness in the blossom; but on particular examination and more mature reflection concluded that they were certain signs of a specific difference in the quality of the wheat: impressed with this idea, he selected the ears of different hues, and particularly marked eleven distinct numbers; noting very minutely their characteristic qualities and appearances in the field.

These he gathered and kept separate when ripe, and planted them apart from each other in his garden; the same characteristic difference was observed to continue upon the several numbers when growing in the garden as was observed in the field the preceding summer, and are as below.

First year in the garden culture.—No. 1. A stiff straw, thick ear, the rows or chests in which set closer than in any other.

2. Dark straw, full blade, and large open ear.
3. A large long ear, ripened late, and well set.
4. Full foliage, and a long open ear.
5. Straight handsome straw, large well-set ears, flag or leaf small.
6. Red rusty leaf before spindling, red straw with little leaf at harvest and smaller ears than any.
7. Very like No. 6. in straw, the ears small, but well set.

8. Straw leafy at harvest, of a good colour, well eared and handsome.

9, 10. Straw full of flag or leaf at harvest, ears set wide.

11. Very like No. 5.

Second year in the garden culture.—No. 1. Short upright stiff straw, thick well-set ears, and later by four or five days than any of the others.

2. Very dark straw, upon which there remained a full dark blade at harvest; long open ears.

3. Strong leafy straw, of a good colour, with a thick long ear, well set, rather later than Nos. 5, 8, and 11.

4. Thick leafy brown straw, with a small ear.

5, 8, 11. Short handsome bright leafy straw, ears long, thick and well set.

6. Long straw with a good deal of flag, ears ill set and open.

7. Straw handsome, but small ears, and subject to root-falling.

9, 10. Long weak straw, very leafy, and subject to root-falling.

It is noticed on these, that the lemon-coloured blossom was observed to attend Nos. 5, 8, and 11; but the colour of Nos. 1 and 3. was not particularly remembered. These are the numbers which had been preserved, Nos. 5, 8, and 11, coming to the sickle about a week earlier than Nos. 1 and 3, the produce of which, when compared with the rejected numbers, is an excess of from six to eight bushels per acre, and weighing about three pounds more to the bushel.

At Bradwell, it is observed, a crop of *Windfor* wheat was had, white grain, white straw, and white chaff, which was a most beautiful sample; the strength of the straw middling.

That of all the different sorts of wheat Mr. Hardy has tried on his farm, the best has been the white egg-shell, and this is the sort most cultivated in Foulness island.

That the *red American* is a sort which yields remarkably well with some; it is much approved in Mersea isle. Some have had the best success with it. But Mr. Strutt, at Terling, sowed a barrel of remarkably beautiful wheat from New York, in part of a field, the rest of which was sown with English wheat, and the American was so blighted in the ear as to produce a poor and miserable grain both in quality and quantity. He sowed it again, and the result was the same, and repeated the experiment the third time, the result again the same, though the adjoining English wheat in all the three years produced a fair crop free from all blight. The *habit* of this wheat, therefore, was not, it is said, changed in three years sowing.

That the *rough chaff*, a white chaff and white grain, with

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a velvet ear; is found about Burnham to be an excellent sort; for there they are subject to strong easterly winds, and it does not shell easily. But some, however, do not like it on heavy land, as it has not straw enough; and think that it should stand till ripe, or it will not thrash well.

And about Hallingburg Rife, and indeed through all the district of the Roodings, they find the *rivet* sort a very useful wheat, which is very general, and is found to yield on that heavy soil much better crops than any common sort; but on lighter soils the Kentish red.

In Norfolk about Reddlesworth they have an opinion that *red wheat* will not answer on black sand, white succeeding to much better advantage. But at Winborough red is only sown by Mr. Salter, the white sorts not answering so well on the heavy soils: it is termed the *old red*. Some prefer the *red chaff*, or red wheat to the white, as being less liable to grow at harvest; white however is a better sample, and produces a better price.

In Hertfordshire the rivet or bearded sort is the common sort on the clays and strong loams about Sawbridgworth, on which it yields more abundantly than the red and white wheats, four or five quarters *per acre* not being uncommon in favourable years. And a sort termed *polled rivets* is also very productive, one hundred grains having been seen in an ear.

About St. Alban's, *Day's stout*, which has the ears growing with four sets of kernels, is much sown: also about Hitchin, where it was discovered by a poor labourer who gathered a few ears. It is said to yield well. It is supposed to be the *pirks* of Ellis. The *red lammas* and *Luswell*, brought from Cambridgeshire, are likewise much sown. On the Albury clays the rivets are grown, yielding largely, but subject to mildew, and selling badly with indifferent straw. They have a *blue* and *white* sort; the latter is preferred.

In most other counties, the same sorts of wheat are likewise cultivated and grown with some other varieties.

In addition to these, there is, however, another species or sort of this grain, which is now much cultivated in some cases, as that which is known by the name of spring-wheat. This is a sort of wheat that is capable of being put into the ground at the same time with other grain crops, in the early spring months. The cultivation of it has been long practised, in some degree, in both the northern and southern parts of the island; but of late a much greater attention has been bestowed upon it, and at present it is raised and grown to considerable extent in different districts and places, as in the fens of Lincolnshire and Cambridgeshire, in many parts of Oxfordshire, in some instances in Berkshire, in Hertfordshire, where it is found to answer well, and in most of the other southern counties, as well as in many parts of the north of England, and even in the lower parts of Scotland.

The common autumn or winter sort of this grain is in general most suited to the heavier descriptions of mellow soils, which do not retain too much moisture. They should however be of a fertile quality, and capable of affording a fine surface mould, for the reception of the grain. But good crops may be raised on the lighter sorts; though the introduction of it on such kinds of land, has been suggested as disadvantageous from their being so much more adapted to the raising of other kinds of crops.

The cone, bearded, or rivet sorts of such wheat are the most proper for the heavier, more moist, and less broken down and reduced kinds of land that have been more lately put in cultivation, on which very weighty crops are not unfrequently produced.

All these sorts of wheat are grown to the most advantage

and with the greatest success, where the bottom in the land is somewhat inclined to be firm and close.

In regard to the spring sort of this grain, it would seem to be capable of being cultivated on the strong and heavy, as well as on the lighter sorts of land; but that it is the most calculated for the latter, where the vegetation and growth are rapid, particularly such fenny lands as have a firm turf-earthly bottom. In these it rises in a very quick manner, and they are not by any means well suited for the winter sorts of wheat from their lightness, rendering them liable to be thrown out in that season.

Preparation of the Land.—Wheat is a crop that is usually grown after the land has been prepared by repeated ploughing and harrowing or summer fallowing; but which is often capable of being raised after different kinds of green crops, as well as those of the root and other sorts with equal or more advantage. In some cases, flax and hemp also afford a good preparation for this grain; but some consider beans as the most favourable preparation: and experiment has shewn tares, and clover, to be nearly equal to them in this intention. In the county of Norfolk, wheat almost constantly succeeds clover, except where pea or bean crops are interposed, the land being scarcely ever fallowed with this view, except in the instances of what are termed *bastard summer tills*. It has indeed been well observed, that if there is one practice in husbandry proved by modern improvement to be worse than another, it is that of sowing wheat on fallows; it is therefore only stated on this point, that in some counties the fallows are ploughed just before harvest on to two-bout ridges ready to plough and sow under the furrow in the spraining method, a seedman to every plough which reverses the ridges. In others they lay their lands into ten or twelve furrow-stitches or ridges, and sow some under the furrow, some under the harrow. That the ridges vary exceedingly, according to their wetness; and that in Kent they have by means of the turn-wrest plough, no lands at all, but a whole field, one even surface. It would be useless to expatiate on the circumstances of fallow-wheat which ought no where to be found. If fallows be or are thought necessary, let them be sown for barley or oats, or with any thing but wheat. However, in whatever manner or after whatever kind of crop this sort of grain may be cultivated, the soil should constantly undergo that sort of preparation that may be sufficient, according to the particular circumstances of the land, to bring it into a state of considerable fineness of mould, especially in the more superficial parts, and thereby prevent as much as possible the rising of weeds; for it has been well noticed by a late writer, that whoever has attended to the progress of this sort of crop, in such lands as have been well broken down and reduced, and in such as have been left in a lumpy crude state at the time of sowing, will have found the difference to be very considerable. But it may be noticed, that when this kind of crop is taken after clover, the land seldom undergoes more than one ploughing, which is mostly given immediately before the seed is sown. However, as the grassy matter, in many cases where this mode is adopted, is extremely apt to rise and injure the crops in the more early stages of their growth, it may be better to follow the practice adopted in some districts of using a skim-coultured plough, as by this contrivance the remains of the clover weeds, and grassy material on the surface, may be cut or skimmed off, and turned into the bottom of the furrows, where they are immediately covered with the loose mould from below to such a depth, that little or no inconvenience can be sustained by them, while the land is thus rendered more clean, and capable of being harrowed in a more perfect manner than where the common plough only is employed.

ployed. Besides, perhaps, a better bed of mould is turned up in this way for the seed to vegetate in, provided the furrow is not made of too great a depth and breadth, and remain some time before it is sown; which should constantly be attended to by the agriculturist in preparing this sort of ground for wheat-crops. But it is the custom of some counties, as of Norfolk and Warwick, where the land is often continued for nearly two years in a state of clover, to break them up in the latter end of June; in the second, giving two, and sometimes three ploughings. Where the situation is favourable, and the weather turns out suitable for reducing the soil to a proper state of tilth, this may be an advantageous practice, as by such means great benefit may be obtained by cutting the grass in the beginning of the season, in which it is to be ploughed up; but where circumstances of so favourable a nature do not occur, such a method of preparation must be less beneficial than that of giving only one ploughing. In the preparation of a clover ley for wheat, Mr. Duckett has noticed a singular experiment and practice. He had a field in which wheat rarely escaped being greatly root-fallen; not to lose sowing it with that grain, and at the same time to guard against the experienced malady, he scarified it repeatedly, till he had torn up the clover, and also produced tilth enough for drilling it in; then he collected the clover fragments, and carted them into the farm-yard to make dung, and drilled the field; the wheat having a firm bottom in an unstirred soil, escaped the disease, and yielded an ample produce. The clover bulb, which would have secured the dreaded looseness of soil, had it been turned down, made a large quantity of dung, and therefore was not lost to the farm, though the particular field was deprived of it. And it has been stated on the authority of a cultivator of much experience, that in cases where the clover-crops have been such as to leave the land in a foul condition in respect to weeds, it would be highly improper to sow them with this sort of grain, as from its remaining for such a great length of time upon the ground they may be liable to have their seeds perfectly evolved, and brought into a state of vegetation. In such cases, it has been suggested as more advantageous to have recourse to such sort of crops as may require the operation of hoeing during the time they are upon the ground. The putting in of wheat after pea-crops, is a practice that may probably be pursued with the most propriety and success in those districts that are, from the nature of their situation, sufficiently early to admit of the land being fully cleaned and prepared by repeated ploughings and harrowings, after such crops have been removed, before the proper time of sowing such grain. But where they are so late as only to allow of the land being prepared by one ploughing before the period of sowing, it is supposed by some to be an extremely hazardous practice to attempt the culture of wheat after such crops; as unless the ground be in a high state of tilth, there is little chance of a good crop being produced. This is the opinion of the writer of the work on modern agriculture; but the Norfolk farmers are in the constant habit of setting or sowing in wheat upon a pea-stubble with a single ploughing, and consider it a very safe and excellent husbandry. The pea-crop ought, however, to have been kept clean; and after it is harvested, the haulm harrowed off. They never plough a bean-stubble there more than once. In some counties, it is the constant practice to cultivate beans and wheat alternately on the same land for some time. This is the case on the stronger kinds of soil in the county of Kent, on which it is found to answer in a very advantageous manner; and where wheat is only occasionally sown after such crops, it is often found an useful practice; but in all such cases the beans should be

cultivated in drills at from twenty to thirty inches distance, in order that they may admit of being hand and horse hoed in the most perfect manner. If this method has been followed, and the business of hoeing during the growth of the crops effectually performed, the land may be sufficiently prepared for the succeeding wheat-crops by one ploughing, as the soil from being thus kept clean, and in high tilth, can scarcely fail of affording a good produce. It has been remarked, that where the farmer has a bean-stubble intended to be sown with wheat, he should give it the due tillage as early as possible, which should be regulated by the soil, as on some it may be better to trust the skim scufflers and scarifiers than the plough. That where the land is very clean, the great skim of the Isle of Thanet is capable of cutting through every thing, and loosening the surface sufficiently to enable the harrows to render it as fine as possible, being picked and burned by women. Where not so clean, the Kentish broodshare may be more effective. In other cases, the scuffler may be sufficient for the purpose. It is noticed that in this case, when the farmer has got the surface to his mind, he is to consider whether or not he should plough it, which is advisable if the soil be of a firm solid tenacious quality, and if he does not intend to drill the wheat: if he should plough such a soil he may not have any apprehension of root-fallen wheat, that is, failing roots, from a loose bottom; but he will bring up a new surface that may drill with difficulty, whereas that which has received the influences of the crop, atmosphere, and of his late operations, will be in exactly the right temper for the drill to work in. If the soil is of a more loose friable quality, and he should plough down the fine surface he has gained, he will give the wheat too loose a bottom, and he will run the chance of a root-fallen crop. In all such cases, or in any that have a tendency to this circumstance, he should determine not to plough at all, but drill directly; a method in which he saves tillage, and has the probability of a better produce.

This is rather a new practice on strong land, but such success has been seen in it as leaves no reason for doubting the soundness of its principles. It was done by Mr. Duckett on a sandy soil for years, and with great effect. It should be remembered, that whatever other circumstances may influence the growth of this grain, it loves a firm bottom to root in, and rarely flourishes to advantage where it is loose and crumbly; nor will a depth of such mould do, if the under stratum, in which it will attempt to fix its roots, be from its quality of a repellent nature. The best basis is the cultivable earth, firm from not having been lately disturbed. These observations, as being quite practical, are certainly deserving of the farmer's attention. Where the district is early, and the land is preserved in good order by proper modes of cropping, wheat may be grown after beans, whether cultivated in the drill or broad-cast system, with success, as there may be sufficient time to give the necessary preparation before the time of sowing, which cannot be done where they are late, and there is only time for one ploughing. But in other situations it is found advantageous when this crop is to be grown after either peas, beans, or tares, to plough the land in as light or shallow a manner as possible, and then harrow and take out the roots and weeds, so that they may be consumed on the ground in heaps; the field being after this formed into proper ridges for the reception of the seed by ploughing again a few inches deeper than the first. And in some cases, it is even harrowed after the second ploughing, and ploughed a third time for the putting in of the grain.

Wheat, too, may sometimes be cultivated after turnip-crops to advantage on the heavier turnip-soils, particularly

where they have been kept clean from weeds by repeated hoeings, and fed off upon the land at such early periods as to admit of the ground being prepared by once ploughing, in a light manner. In cases where this kind of crop is intended to be cultivated after potatoes, which, from their having a great tendency to lighten the soil as well as to exhaust it, should never be done on the lighter sorts of land in backward situations, or under any circumstances where a sufficient proportion of manure has not been applied for the potatoe-crops, one light ploughing immediately before the seed may be in most cases an adequate preparation; as where proper attention has been bestowed in the culture of such crops, the soil is generally left in a sufficiently fine condition for the purpose. It has been remarked, that the cause of wheat not succeeding well after potatoe-crops, in many instances, is, that, besides the land being rendered too light and porous by the growth and cultivation that are requisite for them, the wheat is more exposed to the injurious attacks of the grub, earth-worm, and other insects; and in some exposed situations, from the seed-time being too long protracted, the practice becomes obviously improper. In growing the crop after those of hemp and flax, as weeds are apt to rise, it is always proper that the land should be ploughed over two or three times, in order that a fine state of tilth may be produced. The custom of giving but one earth after such sorts of crops, can seldom or ever ensure full returns of this grain. It has been remarked in "Practical Agriculture," on the best authority, that experience has shewn, in the most clear and satisfactory manner, that this sort of crop should never, when it can be avoided, be grown after other kinds of grain-crops, as rye, barley, or oats; and that the manure should not be applied to it, but for such crops as may precede it. That where the contrary is practised, the crop is not only liable to be injured by the rampant growth of weeds, but from its being more apt to be diseased.

On the whole, it may be observed, that whatever the nature or state of the ground may be, or the kinds of crops that precede this sort of grain, it would appear that the preparation for it should always be such as has a tendency to reduce the parts of the soil to a pretty fine state, as under such circumstances the growth of the crops is not only more regular and perfect, but from the even and compact state in which the surface is left, it is more fit for affording support and protection to the roots of the wheat-plants, as allowing them to spread and extend themselves with greater readiness in the fine mouldy earth thus provided, as well as by its falling down more closely about them. It has, however, been contended by some cultivators, that a rough cloddy state of the surface-part of the land is the most proper situation of it for the reception of this kind of crop, as the young wheat-plants are thereby better guarded and secured against the effects of the severe cold that often takes place in the winter season. It is probable, however, that cold is seldom hurtful, in any great degree, to winter wheat-crops, except when accompanied with too much moisture, or where sudden frosts and thaws have the effect of rendering the surface parts of the soil so light and open, as to be incapable of affording proper support to the roots of the young wheat-plants.

In Berkshire they prepare the land for wheat chiefly in three different ways, as by summer fallowing, and manuring with yard-dung, compost, rags, foot, and chalk in some cases; by folding on it with sheep in cases where the ground is not of too deep and wet a nature; and by putting it in on the back of clover-leys, after one or two crops of grafs by one or more ploughings.

It is thought by some, however, that manuring for beans or other crops is a much better practice when followed by wheat, than the old custom of fallowing and manuring for this crop, which renders the land too light, and consequently subject to blight.

The farmers in Oxfordshire prepare for wheat by different numbers of ploughings, as the circumstances of the land may be; but the layers are mostly ploughed in a shallow manner, as wheat loves a firm bottom to root in, and which, in sandy land, cannot be too tight. Too loose a bottom is apt to cause a root-fallen crop.

An equally careful preparation of the soil is necessary for the spring sort of this grain, though fewer ploughings will often be sufficient.

Time of sowing.—In regard to the proper period of sowing this sort of crop, it may, the author of Modern Husbandry observes, be useful to remark, that the earlier the autumnal sowings can be put into the soil, the greater chance the young plants will have of being well established before the frosts take place, which has been seen to be a circumstance on which the welfare of the crop in a great measure depends. Besides, the state of the land and that of the season are much more proper for the process of vegetation, when the crop is put in at an early period, than when it is delayed till a late one; the state of the weather in the latter case often admitting of only a very languid and imperfect growth till the spring, by which the crop must be exposed to much danger from various causes. Indeed experience has abundantly shewn that late sown wheats seldom succeed so well, or afford such plentiful crops as those that are put in early. But when sown too early there may notwithstanding be danger of the crop running too much to straw, and consequently of the grain proving light in the ear. From the beginning of September to the middle, or even the end of October, may probably be considered as the most favourable period for this business. This is indeed confirmed by the established practice of the most correct farmers in almost every district of the kingdom where this sort of grain is grown. If sown earlier, especially on the heavy kinds of soils, the land is for the most part in too hard and lumpy a state to allow of the seed being properly covered by the harrow; and in the lighter ones in too dry a condition for the grain to vegetate in a proper manner: and when delayed later, the ground in one case is apt to become too wet and close by the falling of the autumnal rains, and in the other too loose and porous from the action of the frost upon it. It is remarked by the writer just mentioned, that more than four-fifths of the whole of this sort of grain is sown between the middle of the first and the end of the last of the above months. Mr. Young thinks September the best season for cold backward wet soils, and October for those of the more dry and warm kinds, after there has been a plentiful rain. There are, however, circumstances, it is farther observed, on the authority of the Synopsis of Husbandry, that may render the times of sowing different from the above; as where the soils are of the rich fertile, loamy, chalky, or gravelly kinds, it may be better to defer it in many instances to a considerably later period; as when such warm sorts of land are cropped too early, they are apt, it is said, to push the plants forward in such a rapid manner, that they become weak and spindling in the early spring months, and at the same time the crops are more liable to be infested with weeds, on account of the season being then more favourable to their growth. But that the practice of putting in crops of this sort so late as the latter end of November and beginning of December, frequently depends on the crops that precede them not being capable, from the lateness of

of the situation, or other causes, of being taken off so early as that the land may be made for the wheat-crop in the proper time. This is often the case after peas, beans, tares, turnips, and other similar crops. In these cases, on the lighter sorts of soils, and where drill culture is employed, it may often be an advisable practice to sow in the spring, as by such a delay the ground may be brought into a more perfect state of preparation than could be the case in sowing it so late in the winter.

It is indeed remarked in the Corrected Report on Agriculture for Middlesex, that those persons who sow wheat in autumn lose the great advantage of a previous crop of turnips, both as to destroying the weeds and manuring the land; and that they create the labour of either hoeing, harrowing, or otherwise tampering with the weeds and young wheat in the following spring. That a wet seed-time sometimes renders it impossible for the farmer of a clayey soil to sow his usual quantity of wheat in autumn; this should not induce him to sow his grain when the land is too wet for the occasion, but rather let him wait till the first favourable opportunity in the months of February or March, by which time frost will have rendered the land mellow, and then he should sow the residue of his wheat; as the probability is great that wheat sown on a mellow soil, in a dry February, will be more productive than if it had been sown on the same land, in an adhesive state, during a wet November.

That autumnal-sown wheat precludes cultivation for one entire year, which, apart from all other circumstances, gives great encouragement to the growth of weeds; but that in order to appreciate the great mischief done by sowing wheat in that season, its connection with the usual course of crops must be taken into consideration. For instance, first, in the ancient, and still very common course of fallow, wheat, oats, there is seldom any ploughing from the sowing of the wheat until the sowing of the oats, which is one year and a half; secondly, in the course of wheat, clover, spring corn, or pulse, there are two years together in which the plough cannot possibly be put into the ground; thirdly, in the valuable course of turnips, barley, clover, and wheat, the plough is shut out of the ground for two years and a half. That these three cases include most of the arable land in Britain, and they demonstrate the prodigious encouragement which such courses give to the growth of weeds. On the contrary, wheat sown in the spring occupies the ground only half a year; and that when that is placed in a succession with winter tares and turnips every two years, the weeds have not time to grow in such a manner as to do any material injury. There is no period in such a course of more than six months in summer, or eight in the winter, free from the operation of the plough. This degree of tillage keeps the land free of weeds, and, in that manner, preserves it from being exhausted by them; and, by giving the green and root crops to sheep and other cattle, on the land, it becomes doubly manured every other year, which cannot fail to force the growth of the wheat as though it were growing in a hot-bed.

It certainly is not in every possible case advisable to refrain from sowing wheat in the autumn, in order to sow it in the spring. A dry seed-time is of so much importance to the occupiers of adhesive and fenny soils, that they should not let any such time pass without sowing their grain. In the case of a dry autumn, which is the same thing as a fine seed-time, the farmers should sow all such land as is then ready, and thereby ensure the important points of a good seed-bed for their grain, and against the danger of a wet spring. On the other hand, the more rain that falls in autumn, the better chance there is of having a dry spring; and consequently in every wet autumn the wheat-sowing

should be postponed until the spring. The proof of the success of one instance of this kind may enable farmers to judge what is capable of being effected, even in an unfavourable situation, by patience in wet seasons, and exertion in such as are dry. A large wheat-farmer, near Haddington, in Scotland, owing to a wet autumn, delayed sowing his wheat until after the 19th day of February, between that time and the middle of March, seeding one hundred and forty-five acres with wheat, principally the Essex white and Egyptian red. The harvest in this case was about ten days later than usual, and the crop yielded from twenty-four to forty Winchester bushels on the acre, which weighed nearly sixty-two pounds each. On examination, the wheat was found a first-rate sample.

Such a successful case of raising fine wheat from the seed sown in the spring may afford reason for putting it in at that season in many cases. Such a practice has never been known to fail, by the writer, when performed early, and on land in good heart. The advantages of the practice are said to be many, and very considerable.

When the sowing is to be done later than the above periods in the spring, the true summer wheat is always to be used.

The exact periods at which this sort of grain may be put into the ground in different cases with the greatest chance of success, under different circumstances of soil and climate, have not hitherto, however, so far as we know, been fully ascertained and shewn by any correct trials; but the above periods of autumn sowing are in very common use by the best farmers.

In the counties of Essex, Suffex, Hertford, Oxford, and many others, most of the best farmers are in favour of early sowing; but more to the east it is done somewhat later. In Berkshire they sow their light lands early, and those that are rich at a later period.

The spring sort of wheat may be sown from about the middle of March to the end of the following month, in most parts towards the south; but most probably the sooner it is put in after that period of the above month, as the state of the season will permit, the better it will be in the crop or produce.

Seed.—In respect to the proportion of seed that is necessary in different cases, it must depend upon and be regulated by a variety of different circumstances, but in general from two to three bushels, according to the state of the soil, the nature of the climate, and the period in which it is put into the ground, may be the most suitable proportion for soils of a medium state of fertility, under the broad-cast method of husbandry; but where the drill system of culture is practised, a considerable less quantity may be sufficient for the purpose. In the drilling and dibbling methods of sowing, however, which are unquestionably the best where they are performed with correctness, six pecks of seed are sufficient; in the latter mode two rows being put in on a flag, care being taken to have the land rolled after having been ploughed a fortnight or more, and the seed dibbled in to a sufficient depth, without scattering, covering it in by bush harrowing.

Where the lands have a known disposition to mildew, a larger proportion of seed should be given, whatever the time or season in which it is put in may be. Much less seed is also necessary in early than late sowings. It is remarked that on the rich soils of Gloucestershire, the quantity generally sown is about seven pecks, while in Yorkshire it is from eight to twelve. Where the lands are in a suitable state of tillage for receiving crops of this grain, ten pecks have been advised by a practical writer as the medium proportion; but

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but much larger quantities are frequently sown in the northern parts of the kingdom. It is obvious, however, that where such large proportions of seed are made use of, the plants must be liable to be drawn up too much, and the crops in consequence to become weak and imperfectly fed, as well as smaller in the size of the ears. There may be also disadvantages from making use of too small proportions of seed, from the ground not being properly covered with plants; but where care is taken in the after-culture of the crops, less danger is probably to be apprehended from this than the other extreme, as a great number of plants will be supplied by the tillering or shooting out of new stems from the joints about the surface, in consequence of the mould being laid up against them.

In Hertfordshire, in the broad-cast method, from two to three bushels are usually sown. But in the county of Norfolk they sow broad-cast, from two to two and a half bushels; and in the drilling and dibbling methods, from five to six or seven pecks.

In Essex they sow broad-cast about two and a half bushels; and in the drilling and dibbling modes, from seven to ten or more pecks.

In Suffex they sow a large quantity of seed, some four bushels on ley land, and three upon tilth; others three and a half: but when this crop succeeds peas, only three, if it be early, but if late, more. The medium quantity is about three.

In Berkshire commonly from two and a half to three in the broad-cast sowings of this crop.

And in Oxfordshire from two to two and a half, and sometimes three.

In the sowing of the spring sort of this grain, the quantity made use of is various. Some, for a full crop, sow fourteen pecks to the acre, but with grass-seeds only nine. Eight pecks have produced an abundant crop in some cases, on the same portion of land. Others advise two bushels to the acre; and say that the earlier it is sown the less seed will be required. Sometimes three bushels are sown upon the acre. However, from two and a half to three bushels on the acre may be considered as the most proper quantity. In the dibbling method, four pecks and a half have been found sufficient for an acre and a half.

The broad-cast practice of putting this sort of crop into the ground is the most common on the heavier kinds of wheat-lands, as those of the clayey and loamy sorts, the seed being harrowed well in by a rather light harrow. But in the lighter sorts of wheat-lands, the drilling method is often practised when they are clean, and sufficiently mellow and mouldy on the surface. Sometimes, too, the seed is put in partly by the plough, and partly by the harrow. In some districts it is ploughed in on the fallows, and harrowed in on clover. The clover-leys are also occasionally ploughed in some cases, and have the seed suffled in, and folded upon by sheep. See *SOWING, SEED, &c.* Also *UNDER-FURROW Sowing.*

Some farmers prefer a stale furrow for sowing wheat upon, while others are in favour of the contrary practice. A stale furrow is probably, however, the best in many cases. See *STALE-Furrow.*

Preparing feed-wheat for sowing is practised in many cases and places in different modes and manners. See *PICKLING, STEEPING, &c.* Also *WHEAT-Seed, Lining of.*

The depth of putting the seed in should not probably be more than from one to two or three inches.

In some parts of Oxfordshire the last is the usual depth,
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and the farmers are generally friendly to depositing the seed to a shallow depth.

It is also the practice with many farmers in these different districts to change their feed-wheat frequently.

In the county of Suffex, an intelligent and spirited farmer has found by long and attentive experience that a change of feed-wheat is of essential importance to the cultivator, as that feed which has been repeatedly sown over the same ground at length degenerates, and the produce each succeeding year becomes inferior in quality; on which account, wheat that is apt to run to straw is sown on ley-land, and the Hertfordshire white sort on pea-stubbles.

In other districts the practice is thought by the best farmers to be always proper; and that the feed-wheat should be brought from a colder soil or sort of land than that on which it is to be sown. See *Change of SEED,* and *SEED.*

As soon as the seed has been put into the land, it should constantly be laid as dry as possible by the construction of proper drains and water-furrows, so as in all seasons to keep the water from stagnating upon it. See *WATER-Furrowing.*

It has been lately suggested as a beneficial practice to have the feed-wheat well trodden in at the time of sowing it by sheep, or still heavier stock, on heavy as well as light soils; as by this means the young plants are prevented from dying away in the winter, from the land lying too light and hollow. But more facts are wanting to establish the utility of this method of practice in different cases. See *TREADING Wheat in,* and *PLOUGH.*

Although under the present practice and management in the cultivation of wheat, the autumn or winter sort must always necessarily occupy a large extent of the heavier kinds of wheat-lands in this country, and be raised in the manner that has been directed above; yet in a number of cases the true spring sort may be cultivated, grown, and had recourse to with great advantage, success, and benefit. But in all such culture, the real summer sort must always be employed, for though the winter kind may be put into the ground with advantage in many cases so late as after the middle of February, as has been seen above, it is better to have this real sort for later spring sowing, as it possesses many properties highly necessary for the purpose. By some it has been supposed that it would interfere with winter wheat, and that it may be difficult to find proper courses for introducing it. However, this sort of wheat should principally be cultivated and grown on soils or lands, and in climates which are not well suited for winter wheat, or in cases where that sort is particularly liable to mildew. But though it may not be suited for universal application, it is most likely to succeed in the lighter, the fenny, and the softer sorts of soil, where the winter wheat is apt to be thrown out of the earth by frosty seasons. In such cases the courses might be turnips, or rape, according to the nature of the land, spring wheat, clover, and oats, or some such rotations, as in such, if after the clover or other grass, the land be pastured for one year, the oat-crops will be certain, and abundantly productive.

The preparation in some cases might be the rendering the land fine and clean by one or more ploughing and proper harrowing, and in others by ploughing and burning, and sowing cole and other feeds and crops, for being fed off by sheep, or in some other such ways.

In this manner large crops have been raised in many different instances, as thirty Winchester bushels, or more, on the acre, which were ripe and ready at the same time with the other spring-sown grain. It is a wheat which is said to

yield as much flour in any given quantity as other wheats, and which does not appear to be subject to any disease, nor to have any disadvantages attending the cultivation of it. It does not require more manure than barley or beans, nor does it exhaust the land more. It answers extremely well for laying down with clover, in which case the clover-seed should be sown and harrowed in with the last harrowing for the wheat, and the usual quantity of grass-seeds sown. It is to be preferred to all other sorts of corn for raising crops of grass-seeds; owing to the small quantity of leaf which it bears, and which is of short duration, as it fades and falls down almost as soon as it has attained its full size: more air is thus admitted to promote the growth of the clover, or other grass; and the admission of more air may also contribute to prevent the mildew with which this sort of wheat is so rarely affected.

There is a further advantage stated to arise in the cultivation of this sort of wheat in some cases, which is, that on various soils, and in some seasons, it often happens that the autumnal-sown crop of wheat may be seen to fail and to go off in patches, from the injury of the wire-worms, or other causes. Consequently, that in the beginning of April, by raking spring wheat into the vacant places, as also where the wheat-plants may appear weak and thin set, the uniformity of the crop may be restored, and the spring wheat be ready for the sickle quite as early as the autumnal sown. And that, although such a mixed crop would render its produce highly improper for seed; for the miller's use it would afford no objection.

The remarks that are given below are the result of much experience and practice in the cultivation of this sort of wheat. It is found that crops of this kind are ready to cut quite as early as the autumnal-sown wheat in similar soils and situations. That it is highly probable that the success of this sort of wheat on clover ley may be found to depend more on the coming season than autumnal-sown wheat; as if the following season should prove dry, the crop would be more hazardous in the former than in the latter. In a dry summer it would seem that this wheat would have a better chance upon land that has been longer upon tillage than upon clover ley. That turnip and rape fallows, where the soil is not too light, seem highly proper for spring wheat. That pea and bean fallows may also in many instances prove eligible for spring wheat; and especially after having been ploughed early in the autumn, and benefited by the winter's rains and frost. That when the spring wheat is harrowed in, at the last light harrowing, clover-seeds, &c. may be sown, the ground will mostly be well set, and the seeds prosper equal to any in other cases. That in the application of top-dressings for this sort of wheat, it may seem, that in a long-continued dry season, the most eligible way would be by applying them at the same time when the wheat is sown. Only once lightly harrowing after may suffice. But that, in a moist and continued rainy season, top-dressing would probably prove to act more powerfully by being sown upon the surface of the soil; because top-dressings are most particularly calculated to invigorate the coronal roots of the wheat-plants, and thereby to cause them to tiller well. And that, when top-dressings are sown on the surface of the soil, the best time of applying them, it may seem, would be when the wheat is grown to the height of three or four inches; because if laid on before the blades of the corn-crop afford a kind of shelter, the finer particles thereof are liable either to be exhaled by the sun, or blown away by high winds, which frequently occur at that season. Moist and showery weather, at that critical period, will always be

found of the highest importance; therefore, the farmer would do well by having due attention to the state of the weather when employed on this business. And that, as a crop of this sort of wheat is so much more valuable than any other kind of spring-sown corn, there are good grounds for supposing that top-dressings cannot any other way be more beneficially employed.

Trials with this sort of wheat in other unfavourable cases of poor wet cold land likewise shew that this sort of grain may be had recourse to with considerable success in different cases. That five quarters *per acre* have been had on rich good land in perfect cultivation of excellent wheat of this kind, when put into the soil so late as the 4th of May. It is evident, that this sort of wheat has a rapid growth, being equally forward at harvest with the autumn-sown crops. That on the whole it seems probable, from the success that has attended this kind of culture in the fen, in the southern and the more northern districts of the kingdom, that it may be advantageously introduced in many different situations and circumstances of arable land.

We have already considered the history, nature, qualities, and many other properties and circumstances in relation to this sort of grain. See *SPRING-Wheat*.

Culture while growing.—In the culture of wheat after it has been put into the soil, there may be some difference, according as it has been sown, according to the preparation of the land, or other circumstances. But in all cases it should be kept perfectly clean and free from weeds, either by the horse or hand hoe, as weeds not only injure the crop in its growth, but lessen the value of its sample when brought to the market. And besides, the stirring of the mould on the surface amongst the plants may frequently be useful in other ways, in addition to that of preventing the growth of seed-weeds; for as in the heavy kinds of soils that are most adapted to this grain, the more superficial parts are liable to become so hard and baked as not to be easily penetrated by the new-formed or coronal roots of the plants in the early spring months, especially when they are very dry, and have been preceded by much wet; loosening of the earth, by any means whatever, must of course be of great utility. This effect is generally shewn to have taken place by the appearance and progress of the crop, which becomes of an unhealthy yellow colour, and advances but little in its growth. In such cases it has been suggested that harrowing once or oftener in a place may be of much service in the early spring months. Where the crops are thin, and of feeble growth, this operation may produce beneficial effects, by affording a sort of earthing up to the weak plants, and thereby promote a more vigorous growth, at the same time that a number of new shoots are sent off from the joints thus covered, and the crop in consequence rendered more full and abundant; and where the grain is too thick upon the ground, it may also be of utility by drawing out and destroying many of the plants. It has likewise been suspected by Dr. Darwin, that many of the root-fibres, by being torn in the operation, may prevent the over luxuriance of the stem and leaves, and by that means promote the more early fructification of the grain.

It has been observed by a late writer, that the practice of scarifying the young drilled wheat-crops should constantly be performed in an effectual manner, and not later than March: but that some have not supposed it to be so very beneficial, from not performing it at the proper time. Mr. Cook has, it is said, contrived two implements for this use, a fixed harrow and scarifier; the former executing its work merely by common tines or teeth, having three rows, which,

WHEAT.

by varying its position diagonally, one, two, or three of them may be brought to act in the space of nine inches, without injury to the rows of wheat-plants. If two, they may, it is said, be drawn in a breadth of three inches; if three, in a space of four inches, and these spaces widened at pleasure, but still so as to keep quite clear of the rows of wheat; and that by loading the harrow, the teeth are forced to a proper depth. Further, that the scarifier has teeth of various breadths; but for working at this season, between nine and twelve-inch rows, the narrowest are to be preferred. By the action of these tools the surface mould is, it is remarked, loosened, and the air admitted, being performed to the depth of two inches with safety, and without mould being raised so as to cover or bury the plants, the earth being only loosened, and not displaced. By these contrivances much work can be accomplished in a very short time. This process is also useful against the attacks of the worms. They horse and hand hoe their wheat-crops repeatedly in Essex, and with great advantage, though very expensive.

But the drilled and dibbled crops, where this method is not employed, particularly in the latter mode, where only one row is placed on a flag, must be hand-hoed in the intervals, which should be done the first time in the beginning of the above month, and a second time towards the end of it, or a little later. Some likewise do it to the broad-cast wheats, but this has been supposed injurious by many. The business of thiffling the wheat-crops should also be carefully performed in May, or in the very early part of the following month, in all cases where it may be necessary. The practice of rolling should also be employed without either having recourse to the harrow, or after it has been used, being highly beneficial where the surface is cloddy, and the operation is executed when the ground possesses a medium degree of moisture, as well by forcing the roots of the wheat into the earth, as by causing the new stems to rise. And in thin light soils, when this sort of grain is cultivated upon them, much benefit may also be produced in this way, by the roots of the plants being prevented from being so easily loosened and thrown out of the ground. And the same practice is recommended as generally useful by some where clover or grass-seeds are sown with wheat-crops, as a means of rendering the vegetation more secure and perfect.

In Berkshire, wheat-crops by the best farmers are hoed every where, and sometimes hand-weeded, the former on strong soils often twice.

By good cultivators in some parts of Oxfordshire, too, all the wheat-crops are hand-hoed in February or March, and weeded afterwards.

And in Sussex, the practice most commonly adopted is to hand-hoe wheat in the spring, sometimes only once, but frequently twice, as the nature of the preceding crop may have been. By some, however, hand-hoeing wheat is disapproved of, they never hoe white corn, having given it up, from a conviction that the crops were never benefited by the practice; but, on the contrary, that mischief was always done by it. On which, it is observed, that should the practice sometimes be right, and sometimes wrong; or right on some soils, and wrong on others, these contrary facts may probably depend on the spring roots, which are said to strike into the air, and enter the ground at some small distance from the stem. If a hand-hoeing be given just before the appearance of those roots, it may, on a bounden surface, prepare for their easy entrance; but if given afterwards, it is probable the effect would be mischievous, would retard the progress of the plant, and force

it to do its work over again, perhaps at a worse season. If this be the case, the benefit which results from hitting the time exactly, may by no means equal the probability of mischief upon a scale of any extent; in which the right time can scarcely be taken for the whole of a crop. It has been heard declared, too, by excellent farmers, that if a person would pay for the hoeing of their wheat, they would not permit the operation, being convinced that it does more harm than good.

It has also been recommended, in such cases where the land is not in a sufficient state of fertility or preparation to bring the crops to perfection, to make use of top-dressings. Substances of both the solid and fluid kinds have been made use of for this purpose; the first consist chiefly of the dung of different sorts of birds, after being brought into a powdery state, bone-dust, foot, peat-ashes, and various saline matters. The latter are principally the drainings of dung-hills, and other similar liquid materials. The former should be thinly sown over the crops with as much evenness as possible, as early in the spring as horses can be admitted upon the land without injury; and if it can be done when the weather is inclined to be moist, it is the better; a roller may then be passed over the crop with advantage. Where the latter substances are made use of, care should always be taken that the plants be not injured by having too large a quantity applied to them. In this practice, the expense should be a primary consideration, and small trials first made where dungs are not to be used. The proper season for performing the business is the beginning of February. See MANURE, and TOP-DRESSING.

It has been suggested, too, that the method of transplanting wheat may be had recourse to in particular cases, with beneficial consequences, as where there are some parts of such crops too thickly set upon the ground, while others are too thin, irregular, or patchy; as by thinning and setting out the plants of such overabundant parts, among those that are deficient, much service may be done to each of them. The first will be rendered more capable of admitting the operation of the hoe, and thereby of supplying more abundant nourishment for the luxuriant vegetation of the plants, and the latter be supplied with the proper number of plants, which could not be accomplished in any other way. And it has been stated, that when raised in the garden, one acre would be capable of affording sets for an hundred, when planted, after being properly divided at the distance of nine inches from each other; and that as the business of transplanting is to be performed in the spring, it is supposed that crops of this grain may be raised in this manner on lands that possess a greater degree of moisture than is suited to the healthy growth of wheat in general. Besides, clean crops may be produced in this way with much greater certainty, as where the ground is ploughed over just before the plants are set out, the grain may rise much quicker from the plants than the weeds from their seeds, and the crop in this way overpower even noxious plants. Advantages of other kinds have been stated by different writers, as the result of this mode of raising wheat-crops. It is a practice, which, as well as that of dibbling, has been had recourse to with success, both in Norfolk and Essex.

The custom of feeding down wheat-crops, where too forward or luxuriant in the early spring months, by means of sheep, is a practice that has been contended to be beneficial in many cases. The good effects, in such instances, according to Dr. Darwin, are supposed to arise from the removal of the upright central stems, by which means different new lateral stems or root scions are sent off or brought

brought forward with more vigour, by the acquisition of a larger proportion of nutritious matter from the joints in consequence, that must otherwise have been exhausted in supporting the central stems. It is, however, a method which has been found by experience to be the most useful on such strong and fertile lands as are apt to produce a larger proportion of straw than can be properly supported. In which cases, advantage has been said to be derived by feeding off the blade at two or more successive times; but in effecting the business, great care is necessary to see that the whole is completed before the crop begins to spindle, otherwise more injury than good may be produced. And on the lighter and poor descriptions of soils, the practice must be employed with great caution, as on such lands the growth of the crops may be so retarded, as to become weak and spindly. Besides, on those lands where they are very light, and the crops thin, injury may frequently be done by many of the plants being pulled up, on account of the closeness of the bite of the sheep. They should, therefore, never be suffered to remain upon the crops when the weather is wet, and the surface of the ground much loosened, or after sudden frosts and thaws; as in such cases much harm may be done by the plants being pulled up and destroyed.

The treading of the animals may, however, be of great service in all the light sorts of wheat-land, and where the crops are thin; as by it the earth will not only be pressed more closely about the roots of the plants, but the stems in many instances so forced into the ground and covered up, that new shoots will be sent off laterally, and the crops be thus rendered more full on the land. But where the soils are very stiff and adhesive, the growth of the crops may be checked and retarded by the practice, and of course the shoots thus caused become weak, affording only small ears and light grain. Observations and experiments have convinced a writer in the Bath Papers, that wheat ought not to be fed down with sheep, unless it be very rank in January; and that such crops should only be fed as were sown early. And it has been suggested, that though this practice has much similarity to that employed in gardening, of stopping the growth of the main stems of some sorts of plants, as those of the cucumber and melon kinds, by rubbing off or cutting away the central buds, in order to expedite their fruiting; yet in wheat-crops, where the principal stems are eaten down, except when they are early, and of very luxuriant growth, the ears of the new shoots may not have time to perfect the seed, and of course become light and shrivelled in the grain, and the new stems from their weakness be more apt to fall down and be lodged. These are circumstances that have been frequently observed to occur by Mr. Tull, in the feeding down of wheat-crops by means of sheep. And that the same philosophical observer supposes, that in the culture of wheat-crops, the most beneficial method is that of promoting, as much as possible, the time of blossoming, while that of ripening is protracted, as it is for the farinaceous reservoir of nutriment, deposited in the cotyledon of the new seed, in order to support the growth of the *coraculum*, or fresh embryo, that the plant is cultivated; which farinaceous deposition is effected in the interval between the blossoming and ripening of the corn, either before the impregnation of the pericarp or seed-vessel, or afterwards; and the weight and plumpness of the rain are thus augmented.

The practice of feeding down young wheats by sheep may, therefore, be often hurtful, by retarding the period of blossoming, as well as by restricting the growth of the stems of the wheat-plants.

Sheep have likewise been employed on young wheat-crops in other views, as it has been remarked, that as the coronal parts of the roots of such crops are liable to be laid bare and exposed for some inches in length about the surface of the earth, during severe frosty winters, the turning in sheep upon them in such circumstances when the ground is moist, and keeping them in motion, may tend to press them into the loose soil, and in that way produce new roots, as well as afford covering and protection to such as have been denuded. And, it is added, that some farmers who contend that much advantage is derived from it, turn sheep upon the crops where danger is apprehended from worms, slugs, and other insects; in order that by keeping them constantly in motion, such animals may either be wholly destroyed, or so fixed in the surface mould as to cause their more gradual death. There is a very great variety of these animals, which are supposed injurious to wheat as well as other crops; and for the destruction of which, lime, foot, and other saline matters, have been had recourse to with supposed advantage. See GRUB, SOOT, &c.

Wheat-crops are supposed to be much injured from different sorts of vegetable diseases, as the *Blight*, *Blast*, *Mildew*, *Smut*, &c. &c. See these different heads.

In the Essex Report it is mentioned, that a disease which had not before been noticed or heard of, was met with at Copdock in that district, which is called the *purples*. The ears affected are perceived at once by their colour, a dirty brown mixed with green, as if part were ripe, with some chests quite green: they feel nearly, but not quite, like blighted or abortive ears, which are brown, while the ears in general of the crop are of a bright red or white; when rubbed in the hand, as if to get the grain, no wheat is found, but apparently the small grains of a flattened indented globular form, and of a darkish purple, greenish or dark hue. It has not the smallest resemblance in appearance or scent to smutty grains or bladders, and is certainly a distinct distemper. In many of these purpled ears are found some grains of good wheat. In order to discover if all the ears from the same root were affected on trial, in many instances they were found all similar from every root. It is very singular that no account that is recollected should have been given of such a strange malady, and so distinct from all others. Smutty ears were found in the same field, under all the common circumstances of that distemper. In Kent, it is said, this distemper is called *cockle-eared*.

It has likewise been noticed, that particular states of the weather have considerable influence on wheat-crops, at particular periods of their growth. As when the season is sufficiently dry, there is seldom much injury done to them during the winter months, however severe they may be in other respects, nor in those of the summer, provided the weather is not too moist about the time of blooming, as where that is the case the crops are mostly deficient in their produce.

And several sorts of weeds are injurious to wheat-crops, where they have been sown upon lands in an imperfect state of preparation, as *charlock* on the light calcareous soils; the *corn poppy*, on those of the chalky kind, as well as *cockle*, *white-darnel*, *puck-needle*, and *couch*: likewise *colt's-foot* on the rather heavy kinds of lands. See these different heads, and WEED and WEEDING.

This sort of crop is shewn to be ripe and ready for the reaper by its straw turning of a yellow colour, its ears beginning to bend in the neck and hang down, there being no greenness in the middle of them, and the grain becoming hard and plump. It is remarked, in the Essex Report on

Agriculture, that some do not like to cut wheat green, except it be the American white, which is brittle, and must be cut early, to prevent a loss of ears. It rarely lays. In Rochford hundred they do not cut till the wheat is ripe; but some few reap while it is yet green. It is, however, observed by a good farmer, that most rough chaff wheats, if they do not stand till fully ripe, will not thresh well.

It is stated, too, in the Norfolk Report on Agriculture, that Mr. Parmenter, miller at Aylesham, a considerable farmer also, and a very intelligent man, remarked that the farmers let their wheat stand too long before cutting. They are apt to have a notion, that when millers give this opinion, it is speaking for their own interest; but he cuts his own wheat before it is ripe, and would do so on the largest scale, if he was not a miller. The quality is far superior, and the corn just as good. And Mr. M. Hill prefers cutting green, and never yet commenced harvest but he wished he had begun three days sooner.

In the first of these Reports on Agriculture, a practice termed *fagging* is noticed as being for the first time met with. When the wheat-crops are very heavy, with broad luxuriant leaves, men with sickles move regularly through it, strike off many of them, for lightening the top, as a preventive against being beaten down by rain. It should be done carefully, or damage may ensue. See REAPING, HARVESTING of Grain, STACKING, and THRESHING.

Produce.—In respect to the quantity of wheat produced upon an acre, it must vary considerably, according to the circumstances of soil and preparation, as well as the state of the season; for it has been found that in some years the yield is under twenty, while in others it is upwards of thirty bushels the acre, the soil and culture being in every respect the same. And the average return of this crop throughout the whole of the kingdom, is probably not more than from three to three and a half quarters. And Mr. Donaldson has, indeed, stated it at not more than three quarters the acre. The greatest crop of wheat, of which the author of the Report on Agriculture for Middlesex has any account, is, it is observed, sixty-eight bushels *per* acre; the least about twelve. The medium between these extremes is forty, which, it is conceived, would be the average of land highly conditioned. But the average produce of Britain does not, it is imagined, exceed one-half of this quantity, and yet, it is thought, that wheat is as certain a crop as any that is cultivated. It is observed, that the yield of several years varies the proportion which wheat bears to the straw in a very great degree, but that the average is about twelve bushels of wheat to each load of straw, weighing eleven hundred weight two quarters and eight pounds. It has been asserted, and probably with truth, that the straw of autumnal-sown wheat is more harsh, and less agreeable to cattle, than the straw of that which is sown in the spring. The weight of wheat by the bushel differs very much in different cases; but in most strong land districts it is usually about sixty-two or three pounds to that quantity.

The yield of wheat is the greatest at the time of reaping, and becomes successively less and less the longer it is kept, so as ultimately, in many cases, to be a disadvantage to the farmer of not less than nearly one shilling in the bushel.

It may be noticed, that it is necessary, with the view of ascertaining the goodness of a sample of wheat, to determine by the eye whether the berry be perfectly fed or full, plump and bright, and whether there be any adulteration proceeding from sprouted grains, smut, or the seeds of weeds; and by the smell, whether there be any improper impregnation, and whether it has been too much heated in the mow or upon the kiln; and finally by the feel to

decide if the grain be sufficiently dry, as when much loaded with moisture, it is improper for the uses of the miller and baker. In cases where a sample handles coarse, rough, and does not slip readily in the hand, it may be concluded not to be in a condition either for grinding or laying up for keeping.

Wheat is usually sold by the farmers to the dealers for being made into flour; and, in some cases, as seed-wheat for other districts, which is very advantageous, as the price in that way is mostly higher. The dealers, who convert it into flour, dispose of that to the different consumers, and the refuse part, as the pollard, to other persons for the food of horses, sheep, hogs, and other animals.

WHEAT, *Brining of.* See BRINING.

WHEAT, *Brush,* that sort of wheat-crop which is grown after oats, barley, or any other such kinds of grain, on light soils of the sandy and other similar sorts.

Brush-wheat crops are common in many of the more northern parts of this country, but the practice of putting wheat-crops in, in this way, is by no means to be much recommended, as they seldom answer any great purpose.

WHEAT, *Buck.* See BUCK-WHEAT.

WHEAT, *Buck,* in Botany. See POLYGONUM *Fagopyrum.*

WHEAT, *Cow,* in Botany and Agriculture. See MELAMPYRUM, and COW-WHEAT.

WHEAT, *Crossing of,* the practice of putting into the soil in sowing two different sorts of this grain of good qualities, in order to raise a new variety of a still better kind. The practice of crossing in this manner has been found to answer perfectly, not only in this case, but in those of peas, apple-trees, &c. by Mr. Knight. In his trials, in years when almost the whole wheat-crops of the country were blighted, the varieties procured by crossing alone escaped, though raised on different sorts of land, and in very different situations and circumstances. See SEED, and VARIETIES.

WHEAT *Fallow,* that sort of complete naked fallow on which wheat is sown. See FALLOW, and FALLOWING.

WHEAT *Grass,* a sort of grass met with in land of some kinds. In the trials made on grasses at Woburn, the qualities of it stand as below.

	Oz.	Lbs.	Oz.
From a rich sandy loam, the produce at the time of flowering was on the acre	196020	=	12251 4
Weight of the grasses when dry	78408	=	4900 8
Weight lost by the produce of the same extent of ground in drying			7350 12
The produce of the same space of land in nutritive matter	7657	=	478 9
In the creeping rooted wheat-grasses, the produce from a light clayey loam, at the time of flowering, was on the acre	196020	=	12251 4
Weight of the grasses raised on the same space when dry	78408	=	4900 8
Weight lost by the produce of the acre in drying			7850 12
The same extent of land afforded in nutritive matter	612510	=	38213 10

Sixty-four drachms of the roots afforded of nutritive matter 5.3 dr. The proportional value of the roots is therefore to that of the grass, as 23 to 8.

WHEAT, *Grinding and converting of, into Flour, &c.,* the art and means of reducing it into this state, in which there are much nicety and difficulty in some cases, especially with the thinner-skinned sorts of this grain.

It is stated by the writer of the work on Agricultural Chemistry, that in this country the difficulty of grinding thin-skinned wheat is in some measure an objection; but that this difficulty is easily overcome by moistening the corn. And on the authority of John Jeffery, esq., the consul-general at Lisbon, the following observations on the subject are given, as transmitted by Sir Joseph Banks. In order to grind hard corn of this sort with the mill-stones used in this country, the wheat must be well screened, then sprinkled with water at the miller's discretion, and laid in heaps, being frequently turned and thoroughly mixed together, which will soften the hulk so as to make it separate from the flour in grinding, and, of course, give the flour a brighter colour; otherwise the stinty quality of the wheat, and the thinness of the skin, will prevent its separation, and will render the flour unfit for making into bread.

The writer has been informed by a miller of considerable experience, and who works his mills entirely with the stones from this country or Ireland, that he frequently prepares the hard Barbary corn of this kind by immersing it in water in close wicker baskets, and then spreading it thinly on a floor to dry; much depends on the judgment and skill of the miller in preparing the corn for the mill according to its relative quality. It is observed, however, that it is not from this previous process of wetting the corn that the weight in the flour of hard corn is increased; but from its natural quality it imbibes considerably more water in making it into bread. The mill-stones must not be cut too deep, but the furrows very fine, and picked in the usual way.

The mills should work with less velocity in grinding hard corn than with soft, and be set to work at first with soft corn, until the mill ceases to work well; then put on the hard corn. Hard wheat always sells at a higher price in the market than soft wheat, on an average of from ten to fifteen per cent.; as it produces more flour in proportion, and less bran than the soft corn.

Flour made from hard wheat is more esteemed than what is made from soft corn; and both sorts are applied to every purpose.

The flour of hard wheat is in general superior to that made from soft; and there is no difference in the process of making them into bread: but the flour from hard wheat will imbibe and retain more water in making into bread, and will consequently produce more weight of bread. It is the practice in Lisbon, and which it is thought would be advisable to adopt in this country, to make bread with flour of hard and soft wheat, which, by being mixed, will make the bread much better. As the most stinty wheats are capable of being readily and easily ground by these means, much advantage may arise from the mixing of the flour of the thin-skinned wheats with those of the thicker-skinned kinds in the forming of bread, as well as in preventing the objections to the cultivation and growth of the former, on account of their steely quality, and grinding hard and with inconvenience. By these means many of the well-harvested and well-kept wheats of this country will be found to be equal to those of any other, for most purposes to which the flour is usually put. See *SPRING-Wheat*, and *WHEAT*. Also *VEGETABLES*.

In the Middlesex Corrected Report on Agriculture, it is stated, that the best flour is mostly used by the pastry-cooks, and the makers of fine biscuits, and the inferior sorts in the making of bread. That these have often the worse kinds of damaged foreign wheats, and other materials, mixed with them in grinding them into flour. And that, if the bread consumed in the metropolis was prepared from the wheat of this country, unmixed with the leaner produce of other nations, the trial detailed below would shew with accuracy

the quantity of bread that could be made from a Winchester bushel of that grain.

One bushel of the wheat of this country, which weighed sixty-one pounds, was taken. It was then ground, and the meal weighed $60\frac{3}{4}$ lbs.; which, on being dressed, produced $46\frac{3}{4}$ lbs. of flour, of the sort called seconds, which alone is used for the making of bread throughout the greater part of this country; and of pollard and bran $12\frac{3}{4}$ lbs., which quantity was bolted, and it produced in sharps 3 lbs., which being sifted produced in good second flour $1\frac{1}{4}$ lb.

The whole quantity of bread-flour obtained from the	lbs.	
bushel of wheat, weighed	-	48
	lbs.	
Fine pollard	-	$4\frac{1}{4}$
Coarse pollard	-	4
Bran	-	$2\frac{3}{4}$
		11
The whole together	-	59
To which add the loss of weight in manufacturing		
the bushel of wheat	-	2
		61

The sack of marketable flour is by law obliged to weigh 240 lbs., which is exactly the produce of five bushels of such wheat; and the sack of flour is constantly supposed to make eighty quarter loaves of bread; and consequently sixteen of such loaves are made from each bushel of such wheat. It is admitted, however, that two or three loaves more than the above quantity can be made from the sack of flour, when it is the genuine produce of good wheat; that is, in the proportion of about sixteen and a half loaves from each bushel of sound grain, and, it may be presumed, sixteen from a bushel of medium corn. The expence of making the sack of flour into bread, and disposing of it, is about 8s.

WHEAT, Indian. See *MAIZE*.

WHEAT, Mildew in. See *MILDEW*.

WHEAT, Must of, is, according to the ingenious Mr. Hatchett, a taint produced by damp upon the alyaceous part of the grain, or starch; and he conceives, that this taint is, in most cases, superficial. He proposes the following as a successful method of removing it.

The wheat must be put into a vessel capable of holding at least three times the quantity, and the vessel filled with boiling water; and the grain should then be occasionally stirred, and the hollow decayed grains, which float, may be removed. When the water has become cold, or in about half an hour, it is drawn off. Then rinse the corn with cold water, and having completely drained it, spread it thinly on the floor of a kiln, and thus thoroughly dry it, stirring and turning it frequently during this part of the process. Phil. Trans. for 1817, part i.

WHEAT Rickstand. See *STADDLE*, and *STAND*.

WHEAT, Root-fallen or Welten, that sort of wheat-crop in which the roots are thrown out of the ground by its lightness or porosity, as caused by frosts or other means. See *WHEAT*, and *WELT-Root*.

WHEAT, Rust in. See *RUST*.

WHEAT-Seed, Liming of, the practice of drying moistened corn of this sort by means of powdery lime. It is the custom in some places to make it wet over-night, with salt or other water, and to dust it over with the lime the next morning before it is sown, mixing it well together in the operation. By the lime, however, thus remaining so short a time on the grain before sowing, it has no time to penetrate into

into the corn; whereas, by moistening the wheat, and leaving it until the succeeding morning well limed, the lime has a greater power, it is supposed, in destroying the smut-powder, than when it remains on it only for half an hour, and is then mostly rubbed off the corn. Half a bushel of the strongest lime is sufficient for a quarter of wheat, when sifted over and mixed well with it.

In this last mode of drying seed-wheat with lime, it is found to be very efficient in preventing the crops from being diseased in some districts. See *STEERING Seed*.

As there is an uncertainty whether the effect in this practice is to be ascribed to the washing of the grain or the lime, some merely moisten the corn for the purpose of making the lime adhere to it; while others are extremely attentive to the liquor made use of and the washing of the seed, and simply make use of the lime for drying it for sowing. Lime is, however, considered as a great preventative of disease in the grain by many. It should always be used while fresh and newly slacked.

WHEAT, Setting of, the practice of putting it into the soil by the hand. In many parts of the vale of the county of Gloucester, they set wheat by the hand and line; but the difficulty of getting on with the work at the proper season, when on a large scale, in consequence of the want of hands, operates against the more general introduction of this practice. When wheat is set by the hand in this way, not more than three pecks of seed are made use of. On clover-leys wheat is often put in by the hand in small channels made across the beds, which have been formed by the plough to the width of half a ley, dropping the seed into them, and leaving a distance of about seven inches between the different channels. This mode is said to be good for late work; and the expence to be about seven shillings the acre, the seed being usually about six pecks. In some other districts the setting of wheat is said to be practised with much success and advantage; but it is probably too tedious and expensive a mode to be had recourse to on any large extent of wheat cultivation. See *DIBBLING*, and *SETTING of Wheat*.

WHEAT, Spring. See *SPRING-Wheat*, and *WHEAT*.

WHEAT, Smyrna, a peculiar kind of wheat that has an extremely large ear, with many lesser or collateral ears coming all round the bottom of the great one.

As this is the largest of all sorts of wheat, so it will dispense with the nourishment of a garden, without being overfed, and requires more nourishment than common husbandry in the large way can give it. In the common way its ears grow not much larger than those of our common wheat.

This sort of wheat seems, of all others, the most proper for the new method of horse-hoeing husbandry, as that method seems capable of giving as much nourishment as the farmer pleases, by often repeating the hoeing. Next to this, the white-cone wheat is best for this sort of husbandry; then the grey-cone wheat.

WHEAT-Stubble, Cutting and Collecting of, the useful practice of mowing and raking together the strong stubbles of wheat-crops, and stacking them up in or near the farm-yards as additional litter, and for other purposes. It should always be done as soon as possible after the wheat has been taken from the fields. See *STUBBLE*.

WHEAT, Tilling of, the throwing out of new shoots, stems, or stalks, from about the roots, so as to increase the thickness of the crops on the grounds. It takes place much more extensively in the autumnal and winter sown wheats than those of the spring sowings. See *TILLER*, and *WHEAT*.

WHEAT, Transplantation of, the practice of putting into the ground the young plants of wheat that have been raised in other places, or which stand too thick on the land. It is

observed in the Middlesex Report on Agriculture, that it is well calculated for increasing the quantity of corn produced from a single grain, and that it may be resorted to for the sake of curiosity when the cultivator has procured a small quantity of some new and very valuable variety of seed; but that a farmer should never extend it to his field culture.

There would be much loss in labour and in other ways, it is supposed, by this practice, and nothing be gained by it. See *TRANSPLANTING*, and *WHEAT*.

WHEAT, White-cone, a term used by our husbandmen, to express a peculiar kind of wheat, which is very strong, and has a large ear.

It is the best kind for sowing in fields subject to the blight; for the stalks of it being, for the most part, solid or full of pith, like a rush, not hollow, like those of common wheat; the insects that cause the blight, seizing on the stalks of other wheat, do this no injury, even though they should attack it; the stalks of this kind being often found full of the black specks, which are always the marks of that insect having been there, and yet the ear full, and the grain good.

This wheat makes very good bread, if the miller does not grind it too small, or the baker make his dough too hard, it requiring to be somewhat larger than other wheat-flour, and somewhat softer in the dough. A bushel of white-cone wheat will make considerably more bread than a bushel of Lammas wheat; but it gives it a somewhat yellowish cast.

WHEAT-Bird, in *Ornithology*, a name given by the people of Virginia to a species of bird, which, after the time of the sowing of the wheat in that country, made its appearance annually at the season of its beginning to ripen, and was never seen there before. See *MIGRATION of Birds*.

WHEAT-Ear, the English name of the common *ænanthe*, or *motacilla ænanthe* of Linnæus, called also the *white-tail* or *fallow-finch*. See *MOTACILLA Ænanthe*.

WHEATEN-BREAD. See *THEORY of Bread*, and *WHEAT, Grinding of, &c.*

WHEATFIELD; in *Geography*, a township of Pennsylvania, in the county of Indiana, with 1475 inhabitants.

WHEATLY, FRANCIS, in *Biography*, was born in London in 1747, and received his first instruction as an artist in Shipley's drawing-school. Whilst young he received several premiums from the Society for the Encouragement of Arts, &c. He does not appear to have had any particular instructor in painting, but by his own industry and ingenuity contrived to obtain some knowledge of it; and having formed an intimacy with Mr. Mortimer, whom he assisted in painting the ceiling at Brockett-hall, by that circumstance obtained considerable improvements. He had great employment in painting small whole-length portraits, to which he added landscape back-grounds with considerable taste. After practising some years in London, he went to Ireland, and was much employed in Dublin, where he painted a large picture of the Irish house of commons, with portraits of the most considerable political characters, by which he acquired great reputation. On his return to London he painted a picture of the soldiery attacking the rioters in 1780, which was well engraved by Heath.

About this time he appears to have changed his practice, and painted rural and domestic subjects in a manner which evidently exhibits them to have been the offspring of the natural bent of his mind. He was engaged in the Shakespeare Gallery, but failed to excite interest: neither his talent nor his style was suited to the character of the subjects given to him. In the slighter subjects of common life he was at home, and he touched them and composed them in a most agreeable manner, and with a very pleasing tone of colour:

colour: these he executed with rapidity, and, as he always fold them, he acquired sufficient money to indulge a natural propensity to the pleasures of the table. Hence he became a martyr to the gout, and died of that disease in 1801, at the age of 54. He was elected an academician in 1791.

WHEE, WHEY, *Whie*, or *Qui*, in *Rural Economy*, a term used to signify a young heifer, or heifer-calf, in different places and parts of the country.

WHEEANG, or WHANG, a provincial term made use of to signify a thong or strap of leather for the harness or gear of farm-teams, or other domestic purposes.

WHEEL, ROTA, in *Mechanics*, a simple machine, consisting of a round piece of wood, metal, or other matter, which revolves on an axis.

For an account of the *wheel* and *axle*, as a mechanical power, see *AXIS* in *Peritrochio*, and *MECHANICAL Powers*.

The wheel is one of the principal mechanic powers. It has place in most engines: in effect, it is of an assemblage of wheels that most of our chief engines are composed. Witnesses clocks, mills, &c.

Its form is various, according to the motion it is to have, and the use it is to answer. By this it is distinguished into *simple* and *dented*.

WHEELS, *Simple*, are those whose circumference and axis are uniform, and which are used singly, and not combined. Such are the wheels of carriages, which are to have a double motion; the one circular about their axis; the other rectilinear, by which they advance along the road, &c. which two motions they appear to have; though, in effect, they have but one: it being impossible the same thing should move, or be agitated, two different ways at the same time.

This one is a spiral motion; as is easily seen, by fixing a piece of chalk on the face of a wheel, so as that it may draw a line on a wall, as the wheel moves. The line it here traces is a just spiral, and still the more curve, as the chalk is fixed nearer the axis.

The fact, however, has been disputed; and it has been alleged, that nothing is more easy than for any one, who will take the trouble to make the experiment, to prove its falsehood. Place the chalk on the face of the wheel, as directed, and you will find that, so far from its describing a just spiral, and that still the more curve as the chalk is fixed nearer the axis, the chalk, if placed on the periphery of the wheel, will describe a cycloid, and the nearer it is placed to the axis, the nearer will the line it describes approach to the straight line which is described by the axis itself. Moreover, it is not true, nor pretended to be so, that the same thing moves two ways at once in the rectilinear and circular motion of wheels. The local motion, or motion of the whole wheel, is rectilinear only; that of the parts of the wheel circular. Nor can this latter motion with any propriety be called that of the wheel, unless the same thing could also move quick and slow at the same time, which the different parts of the wheel, in revolving round its axis, evidently do. Jacob's *Obs.* on the *Structure and Draught* of *Wheel-Carriages*, 1773, p. 28, &c.

For a very nice phenomenon, in the motion of these wheels, see *ROTA Aristotelica*.

We shall add, that, in wheels of this kind, the height should always be proportioned to the stature of the animal that draws or moves them. The rule is, that the load and the axis of the wheels be of the same height with the power that moves them; otherwise the axis being higher than the beast, part of the load will lie upon him; or, if it be lower, he pulls to disadvantage, and must exert a greater force. Though *Stevinus*, *Dr. Wallis*, &c. shew, that, to draw a

vehicle, &c. over waste uneven places, it were best to fix the traces to the wheels somewhat lower than the horse's breast. See *WHEELS of Coaches*, &c.

The power of these wheels results from the differences of the radii of the axis, and circumference. The canon is this: "As the radius of the axis is to that of the circumference, so is any power to the weight it can sustain hereby."

This is also the rule in the axis in *peritrochio*; and, in effect, the wheel, and the axis in *peritrochio*, are the same thing; only, in theory, it is usually called by the latter name, and in practice by the former.

WHEELS, *Dented*, are those either whose circumference, or axis, is cut into teeth, by which they are capable of moving and acting on one another, and of being combined together.

The use of these is very conspicuous in clocks, jacks, &c.

The power of the dented wheel depends on the same principle as that of the simple one. It is only that to the simple axis in *peritrochio*, which a compound lever is to a simple lever.

Its doctrine is comprised in the following canon; *viz.* "The ratio of the power to the weight," in order for that to be equivalent to this, "must be compounded of the ratios of the diameter of the axis of the last wheel to the diameter of the first; and of the ratio of the number of revolutions of the last wheel, to those of the first, in the same time." But this doctrine will deserve a more particular explanation.

1. Then, if the weight be multiplied into the product of the radii of the axes, and that product be divided by the product of the radii of the wheels, the power required to sustain the weight will be found. Suppose, *e. gr.* the weight *A* (*Plate XL. fig. 83. Mechanics*,) = 6000 pounds, *BC* = 6 inches, *CD* = 34 inches, *EF* = 5 inches, *EG* = 35 inches, *HI* = 4 inches, *HK* = 27 inches: then will $BC \times EF \times HI = 120$; and $CD \times EG \times HK = 32130$. Hence the power required to sustain the weight, will be $6000 \times 120 \div 32130 = 22\frac{1}{2}$ very nearly; a small addition to which will raise it.

2. If the power be multiplied into the product of the radii of the wheels, and the factum be divided by the product of the radii of the axes; the quotient will be the weight which the power is able to sustain. Thus, if the power be $22\frac{1}{2}$ pounds; the weight will be 6000 pounds.

3. A power and weight being given, to find the number of wheels, and in each wheel the ratio of the radius of the axis, to the radius of the wheel; so as that the power, being applied perpendicularly to the periphery of the last wheel, may sustain the given weight.

Divide the weight by the power; resolve the quotient into the factors which produce it. Then will the number of factors be the number of wheels; and the radii of the axes will be to the radii of the wheels, as unity to the several wheels. Suppose, *e. gr.* a weight of 3000 pounds, and a power of 60, the quotient of the former by the latter is 50, which resolves into these factors, 4. 5. 5. 5. Four wheels are, therefore, to be made; in one of which, the radius of the axis is to the radius of the wheel, as 1 to 4; in the rest, as 1 to 5.

4. If a power move a weight by means of two wheels, the revolutions of the slower wheel are to those of the swifter, as the periphery of the swifter axis is to the periphery of the wheel that catches on it.

Hence, 1. The revolutions are as the radius of the axis *FE* to the radius of the wheel *DC*. 2. Since the number

ber of teeth in the axis F D, is to the number of teeth in the circumference of the wheel M, as the circumference of that to the circumference of this; the revolutions of the slower wheel M, are to the revolutions of the swifter N, as the number of teeth in the axis to the number of teeth in the wheel M, which it catches.

5. If the factum of the radii of the wheels G E, D C, be multiplied into the number of revolutions of the slowest wheel, M, and the product be divided by the factum of the radii of the axes which catch into them, G H, D E, &c. the quotient will be the number of revolutions of the swiftest wheel O. *E. gr.* If G E = 8, D C = 12, G H = 4, D E = 3, and the revolution of the wheel M be 1; the number of revolutions of the wheel O will be 8.

6. If a power move a weight by means of divers wheels, the space passed over by the weight, is to the space of the power, as the power to the weight. Hence, the greater the power, the quicker is the weight moved; and *vice versa*.

7. The spaces passed over by the weight and the power, are in a ratio compounded of the revolutions of the slowest wheel, to the revolution of the swiftest; and of the periphery of the axis of that, to the periphery of this. Hence, since the spaces of the weight and the power are reciprocally as the sustaining power is to the weight; the power that sustains a weight will be to the weight, in a ratio compounded of the revolutions of the slowest wheel, to those of the swiftest, and of the periphery of the axis of that, to the periphery of this.

8. The periphery of the axis of the slowest wheel, with the periphery of the swiftest wheel, being given; as also the ratio of the revolutions of the one, to those of the other; to find the space which the power is to pass over, while the weight goes any given length.

Multiply the periphery of the axis of the slowest wheel into the antecedent term of the ratio, and the periphery of the swiftest wheel into the consequent term; and to these two products, and the given space of the weight, find a fourth proportional: this will be the space of the power. Suppose, *e. gr.* the ratio of the revolutions of the slowest wheel, to those of the swiftest, to be as 2 to 7, and the space of the weight 30 feet; and let the periphery of the axis of the slowest wheel be to that of the swiftest, as 3 to 8: the space of the power will be found 280. For $2 \times 3 : 7 \times 8 :: 30 : 280$.

9. The ratio of the peripheries of the swiftest wheel, and of the axis of the slowest; together with the ratio of their revolutions, and the weight, being given: to find the power able to sustain it.

Multiply both the antecedents and the consequents, of the given ratios into each other, and to the product of the antecedents, the product of the consequents, and the given weight, find a fourth proportional: that will be the power required. Suppose, *e. gr.* the ratio of the peripheries 8 : 3; that of the revolutions 7 : 2, and the weight 2000; the power will be found 214 $\frac{2}{7}$. For $7 \times 8 : 2 \times 3 :: 2000 : 214\frac{2}{7}$. After the same manner may the weight be found; the power, and the ratio of the peripheries, &c. being given.

10. The revolutions the swiftest wheel is to perform while the slowest makes one revolution, being given; together with the space the weight is to be raised, and the periphery of the slowest wheel; to find the time that will be spent in raising it.

Say, As the periphery of the axis of the slowest wheel is to the given space of the weight; so is the given number of revolutions of the swiftest wheel to a fourth proportional:

which will be the number of revolutions performed while the weight reaches the given height. Then, by experiment, determine the number of revolutions the swiftest wheel performs in an hour; and, by this, divide the fourth proportional found before. The quotient will be the time spent in raising the weight. Wolf. Elem. Math. tom. ii. p. 214, &c.

WHEELS of a Clock, &c. are the crown wheel, contrate wheel, great wheel, second wheel, third wheel, striking wheel, detent wheel, &c. See CLOCK and WATCH.

WHEELS of Coaches, Waggon, &c. With respect to these, the following particulars are collected from the experiments and reasonings of Camus, Defaguliers, Beighton, Ferguson, Brewster, &c.

1. The use of wheels, in the draught of carriages, is two-fold; *viz.* that of diminishing, or of more easily overcoming the resistance arising from the friction of the carriage, and that of more readily surmounting obstacles, which form angular prominences on the plane over which they are drawn, and which must be either depressed by the weight of the carriage, or render it necessary for the carriage, with its load, to be lifted over them. They serve in their first use to transfer the friction from the under surface of the carriage, and the plane supporting it, to the surfaces of the axle and nave of the wheel. The common method of accounting for this advantage is by saying, that the resistance, arising from friction in planes of equal asperity, increases with the velocity of the motion; so that this velocity must be compared with that of the power necessary to move the machine, and overcome the friction; and it is obvious, at the same time, that the velocity of a circular motion diminishes gradually from the circumference to the centre. See FRICTION.

But to this position it has been objected, that the illustration is not applicable to the case: for, granting that, in the friction of sledges or flat surfaces, the resistance increases in proportion to the velocity of their motion, this is not a parallel case with that of a circular surface rolling over a flat plane. On the contrary, the velocity of motion, in the outer surface of a wheel, is greater than that of its nave, moving under the axle; while at such outer surface there is little or no friction at all; whereas at the nave, moving much slower, there is much more. Indeed, the friction, which the wheel would have against its supporting plane, if it did not turn round its axis, is by its turning round transferred almost wholly to the axis and nave; whose circular motion is notwithstanding so much slower. It is, indeed, notorious, that the great friction of the wheels of carriages lies between the axle and nave; and how then can it be properly asserted, that such friction is diminished at the axle, as the velocity of the circular motion is there diminished? Accordingly it has been alleged by a late writer, that friction is not diminished by the use of wheels, but merely transferred from the outer surface of the wheel to its nave and axle; and that in the case of a wheel rolling along the ground, the spokes act only as single levers, to overcome the friction of the periphery against the plane of its support, the prominences, constituting the roughness of the plane over which it moves, being the fulcra upon which they turn, and not the common centre of these spokes, as others have maintained, who say that the wheel acts, in overcoming friction, as an axis in peritrochio. However, in obviating the friction of the wheels in loaded carriages, their spokes act as double levers, resting on a fulcrum at each end. See the author's method of illustrating and evincing these principles, in Jacob's Obs. on Wheel-Carriages, p. 23, &c.

If carriages were to move along smooth horizontal planes,
Z z wheels

wheels would be useful only in overcoming friction; but as they are drawn along roads covered with loose stones, indented with cavities, they are farther useful in serving to depress, or raise the carriage over the one, and in raising it out of the other.

2. The wheels of all carriages ought to be exactly round; and the fellys should be at right angles to the naves, according to the inclination of the spokes, *i. e.* the plane of the curvature of the wheel should cut the nave at right angles, though it need not pass through the place where the spokes are inserted into the nave.

3. The spokes, according to Mr. Ferguson and most other writers on mechanics, should be inclined to the naves, so that the wheels may be dishing or concave. If, indeed, the wheels were always to go upon smooth and level ground, it would be best to make the spokes perpendicular to the naves, or at right angles with the axles; because they would then bear the weight of the load perpendicularly, which is the strongest way for the wood. But because the ground is generally uneven, one wheel often falls into a cavity or rut, when the other does not, and then it bears much more of the weight than the other does; in which case dishing wheels are best, because the spokes become perpendicular in the rut, and therefore have the greatest strength when the obliquity of the road throws most of its weight upon them; whilst those on the high ground have less weight to bear, and therefore need not be at their full strength. Besides, by this form of the wheels, the base of the carriage is extended, and it is thus prevented from being easily overturned, and the fellys are hindered from rubbing against the load or the sides of the cart. Dr. Brewster, however, is of opinion, that the disadvantages of concave wheels overbalance their advantages. Mr. Antice also, in his "Treatise on Wheel-Carriages," whilst he recommends concave wheels, candidly allows, that some disadvantages attend this construction of them; for the carriage thus takes up more room on the road, so that it is more unmanageable; and when it moves upon plane ground the spokes not only do not bear perpendicularly, by which means their strength is lessened, but the friction upon the nave and axle is made unequal, and so much the more as they are the more dished. Dr. Brewster farther shews, that they are more expensive, more injurious to the roads, more liable to be broken by accidents, and less durable in general, than those wheels in which the spokes are perpendicular to the naves. From these and other considerations, our author is decidedly of opinion, that if wheels are to be composed of naves, spokes, and fellys, the rim should be cylindrical, and the spokes perpendicular to the naves; whereas in concave wheels, the rims are uniformly made conical, which subjects them to a variety of disadvantages. Every cone that is put in motion upon a plane surface will revolve round its vertex, and if force is employed to confine it to a straight line, the smaller parts of the cone will be dragged along the ground, and the friction greatly increased. Now when a cart moves upon conical wheels, one part of the cone rolls while the other is dragged along, and though confined to a rectilinear direction by external force, their natural tendency to revolve round their vertex occasions a great and continued friction upon the linch-pin, the shoulder of the axle-tree, and the sides of deep ruts.

Dr. Brewster has made some farther observations on the construction of certain parts of the wheels. The iron plates, he says, of which the rims are composed, should never be less than three inches in breadth, as narrower rims sink deep into the ground, and therefore injure the roads and fatigue the horses. See the sequel of this article.

4. The axles of the wheels ought to be perfectly straight, and at right angles to the shafts, or to the pole. When the axles are straight, the rims of the wheels will be parallel to each other, and then they will move the easiest, because they will be at liberty to go on straight forwards. But in the usual way of practice, the axles are bent downwards at their ends; which brings the sides of the wheels next the ground nearer to one another than their higher sides are; and this not only makes the wheels to drag sideways as they go along, and gives the load a much greater power of crushing them than when they are parallel to each other, but also endangers the overturning of the carriage when any wheel falls into a hole or rut, or when the carriage goes on a road which has one side lower than the other, as along the side of a hill. Thus, in the hind view of a waggon or cart, let A E and B F (*Plate XL. fig. 9. Mechanics*) be the great wheels parallel to each other, on their straight axle K, and H C I the carriage loaded with heavy goods from C to G. Then as the carriage goes on in the oblique road A a B, the centre of gravity of the whole machine and load will be at C; and the line of direction C d D falling within the wheel B F, the carriage will not overset. But if the wheels be inclined to each other at the ground, as A E and B F are (*fig. 10.*), and the machine be loaded as before from C to G, the line of direction C d D falls without the wheel B F, and the whole machine tumbles over. When it is loaded with heavy goods which lie low, it may travel safely upon an oblique road, so long as the centre of gravity is at C (*fig. 9.*), and the line of direction C d D falls within the wheels; but if it be loaded high with lighter goods from C to L (*fig. 11.*), the centre of gravity is raised from C to K, which shews the line of direction K k without the lowest edge of the wheel B F, and then the load oversets the waggon. Mr. Beighton has offered several reasons to prove, that the axles of wheels ought not to be straight: for which we must refer to *Desaguliers' Exp. Phil. vol. ii. Appendix, p. 540, &c.* Moreover, if the axle were not at right angles to the pole or shaft, but this was on one side, then the coach or carriage would be drawn on one side, and almost all the weight would bear upon one horse. With some mechanics, it is a practice to bend the ends of the axle-trees forwards, and thus make the wheels wider behind than before. Mr. H. Beighton maintains, that wheels in this position are more favourable for turning; since, when the wheels are parallel, the outermost would press against the linch-pin, and the innermost would rub against the shoulder of the axle-tree. In rectilinear motions, however, these converging wheels occasion a great deal of friction, both on the axle and the ground, and must therefore be more disadvantageous than parallel ones. This fact is allowed by Mr. Beighton: but he seems to found his opinion upon this principle; that as the roads are seldom straight lines, the wheels should be more adapted to a curvilinear than to a rectilinear motion.

5. Large wheels are always more advantageous for rolling than small ones, in any case, or upon any ground whatever. If we consider wheels with regard to their friction upon the axles, it is evident, that small wheels must turn as much oftener round than the large ones, as their circumferences are less; and, therefore, a wheel which is twice as large as another will have twice the advantage in respect of the friction, the holes of the naves and axles, and the weights upon them, being equal. Again, if we consider the wheels as they sink into the earth, or fall into holes, the bearing of the great wheel being double that of the small one, it would sink but half so deep; and if the small wheel should meet with a hole of the same diameter with itself, it would wholly sink in, whilst only a segment less than half of the great wheel

WHEEL.

wheel would fall in: the same thing would also happen in marshy ground, where the small wheel would sink wholly in the same hole which the great one would sink into but in part. The large wheel would also have the advantage of a small one in rising over eminences or ruts that occurred; so that the former would go over ruts much higher than the latter; and indeed over any eminences, provided their height be not equal to its semidiameter. Desaguliers has reduced this matter to a mathematical calculation, in his *Exp. Phil.* vol. i. p. 171, &c.

A late writer has also proved, that a wheel of eight feet diameter has somewhat more than twice the advantage in overcoming obstacles of a wheel of two feet; and he found, in practice, that if it requires a certain power to draw a carriage of a certain weight over a certain obstacle, with wheels of any determinate diameter, it will require wheels of four times that diameter, to draw the same carriage over the same obstacle with half that power. This writer also observes, that, in the draught of carriages ascending inclined planes, the moving power acts not only against the vis inertiae, which is always equal to the absolute gravity of the load, but also against its relative gravity, which increases with the inclination of the plane; and with respect to carriages raised on wheels, it is to be observed, that the higher the axle is removed from the plane, the farther is the centre of gravity removed out of the perpendicular line of support; so that the lower the wheel, the less is the relative gravity of the carriage. Hence he infers, that supposing the friction of two carriages of equal weight, but of different sized wheels, to be equal, the low-wheeled one would be drawn up hill, on a smooth plane, much more easily than the high-wheeled one; though on a smooth, horizontal plane, the latter would be drawn more easily than the former. On the contrary, in going down hill, the high-wheeled carriage will be urged forward, by its relative gravity, more than the low-wheeled one. *Jacob, ubi supra, p. 63, &c.*

It appears, therefore, that the larger wheels are, the more advantageous they are in proportion, provided that they are not more than five or six feet in diameter; for when they exceed these dimensions, they become heavy; or if they are made light, their strength is proportionably diminished, and the spokes, being long, are more liable to break: besides, horses applied to such wheels, would be incapable of exerting their utmost strength, by having the axles higher than their breasts, so that they would draw downwards; as in small wheels the draught is made more difficult, by the horses drawing upwards.

It is observed by Dr. Brewster, in the appendix to his edition of "*Ferguson's Mechanics*," that when the wheels of carriages either move upon a level surface, or overcome obstacles which impede their progress, they act as mechanical powers, and may be reduced to levers of the first kind. In order to elucidate this remark, which is of great importance in the present discussion, let *A* be the centre, and *BCN* the circumference of a wheel 6 feet in diameter, and let the impelling power *P*, which is attached to the extremity of a rope *ADP*, passing over the pulley *D*, act in the horizontal direction *AD*. Then, if the wheel is not affected by friction, it will be put in motion upon the level surface *MB*, when the power *P* is infinitely small. For since the whole weight of the wheel rests on the ground at the point *B*, which is the fulcrum of the lever *AB*, the distance of the weight from the centre of motion will be nothing, and therefore the mechanical energy of the smallest power *P*, acting at the point *A*, with a length of lever *AB*, will be infinitely great when compared with the resistance of the

weight to be raised; and this will be the case, however small the lever *AB*, and however great be the weight of the wheel. But as the wheels of carriages are constantly meeting with impediments, let *C* be an obstacle six inches high, which the wheel is to surmount. Then the spoke *AC* will represent the lever, *C* its fulcrum, *AD* the direction of the power; and if the wheel weighs 100 pounds, we may represent it by a weight *W*, fixed to the wheel's centre *A*, or to the extremity of the lever *CA*, and acting in the perpendicular direction *AB*, in opposition to the power *P*. Now the mechanical energy of the weight *W* to pull the lever round its fulcrum in the direction *AE*, is represented by *CE*, while the mechanical energy of an equal weight *P* to pull it in the opposite direction *AF*, is represented by *CF*; an equilibrium, therefore, will be produced, if the power *P* is to the weight *W* as *CE* to *CF*, or as the sine is to the cosine of an angle, whose versed sine is equal to the height of the obstacle to be surmounted; for *EB*, the height of the mound *C*, is the versed sine of the angle *BAC*, and *CE* is the sine, and *CF* the cosine of the same angle. In the present case, where *EB* is six inches, and *AB* three feet, *EB*, the versed sine, will be 1666, &c. when *AB* is 1000; and, consequently, the angle *BAC* will be $33^{\circ} 33'$, and *CE* will be to *EF*, as 52 to 83, or as 66 to 100. A weight *P*, therefore, of 66 pounds, acting in a horizontal direction, will balance a wheel six feet diameter, and 100 pounds in weight, upon an obstacle six inches high; and a small additional power will enable it to surmount that obstacle. But if the direction, *AD*, of the power, be inclined to the horizon, so that the point *D* may rise towards *H*, the line *FC*, which represents the mechanical energy of *P*, will gradually increase, till *DA* has reached the position *HA*, perpendicular to *AC*, where its mechanical energy, which is now a maximum, is represented by *AC*, the radius of the wheel; and since *EC* is to *CA* as 53 to 1000, a little more than 53 pounds will be sufficient for enabling the wheel to overcome the obstacle.

Proceeding in this way, it will be found, says our author, that the power of wheels to surmount eminences increases with their diameter, and is directly proportional to it, when their weight remains the same, and when the direction of the power is perpendicular to the lever which acts against the obstacle. Hence we see the great advantages which are to be derived from large wheels, and the disadvantages which attend small ones. There are some circumstances, however, which confine us within certain limits in the use of large wheels. When the radius *AB* of the wheel is greater than *DM*, the height of the pulley, or of that part of the horse to which the rope or pole *DA* is attached, the direction of the power, or the line of traction *AD*, will be oblique to the horizon as *A d*, and the mechanical energy of the power will be only *A e*, whereas it was represented by *AE* when the line of traction was in the horizontal line *DA*. Whenever the radius of the wheel, therefore, exceeds four feet and a half, the height of that part of the horse to which the traces should be attached, the line of traction *AD* will incline to the horizon, and by declining from the perpendicular *AH*, its mechanical effort will be diminished; and since the load rests upon an inclined plane, the trams or poles of the cart will rub against the flanks of the horse, even in level roads, and still more severely in descending ground. Notwithstanding this diminution of force, however, arising from the unavoidable obliquity of the impelling power, wheels exceeding four and a half feet radius have still the advantage of smaller ones; but their power to overcome resistances does not increase so fast as before. Hitherto we have supposed the weight of the large and small wheels to be the same, but

it is evident that when we augment their diameter we add greatly to their weight; and by thus increasing the load, we sensibly diminish their power.

From these remarks, we see the superiority of great wheels to small ones, and the particular circumstances which suggest the propriety of making the wheels of carriages less than four feet and a half radius. But even this size is too great; and it may be safely asserted that they should never exceed six feet in diameter, nor ever be less than three feet and a half.

6. Carriages with four wheels, as waggons or coaches, are much more advantageous than carriages with two wheels, as carts and chaises; for in applying horses to a carriage with two wheels, it is plain that the tiller carries part of the weight, in whatsoever manner it be kept in equilibrio upon the axle. In going down a hill, the weight bears upon the horse; and in going up a hill, the weight falls the other way, and lifts the horse, by which means part of his force is lost. Besides, as the wheels sink into the holes in the road, sometimes on one side, sometimes on the other, the shafts strike against the tiller's flanks, which is the destruction of many horses. Add to this, that when one of the wheels sinks into a hole or rut, half the weight will fall that way, whereby the carriage will be in danger of being overturned.

7. It would be much more advantageous to make the four wheels of a coach or waggon large, and nearly of a height, than to make the fore-wheels of only half the diameter of the hind-wheels, as is usual in many places. The fore-wheels of carriages have commonly been made of a less size than the hind ones, both on account of turning short, and to avoid cutting the braces. Crane-necks have also been invented for turning yet shorter, and the fore-wheels have been lowered, so as to go quite under the bend of the crane-neck. See an account of an ingenious contrivance for this purpose, under PERCH.

Some carriers and coachmen have, indeed, absurdly alleged, that when the fore-wheels are much lower than the hind ones, they serve to push them on. However, many disadvantages attend this construction. A considerable force is lost that would be effectual, if they were large: the carriage would go much more easily, if the fore-wheels were as high as the hind-ones; and the higher the better, because their motion would be so much the slower on their axles, and consequently the friction proportionably diminished. The jolting and uneasy motion occasioned by low wheels, has induced persons to contrive springs, in order to prevent it. But nothing can be more inconsistent, even with this end, than the common method of fixing the braces to the bottom of the body of a carriage. In consequence of this practice, the centre of gravity of the suspended body is so high above the centre of its motion, that it is liable to be continually agitated by the jolting of the carriage, and its danger of overturning increased: whereas if, instead of practising this method, the body were suspended as near as possible to its centre of gravity, the agitation of the carriage, as well as its danger of overturning, would be in a great measure avoided.

The effect of the suspension of a carriage on springs is to equalize its motion, by causing every change to be more gradually communicated to it, by means of the flexibility of the springs, and by consuming a certain portion of every sudden impulse in generating a degree of rotatory motion. This rotatory motion depends on the oblique position of the straps suspending the carriage, which prevents its swinging in a parallel direction; such a vibration as would take place if the straps were parallel, would be too extensive, unless they were very short, and then the motion would be some-

what rougher. The obliquity of the straps tends also in some measure to retain the carriage in a horizontal position: for if they were parallel, both being vertical, the lower one would have to support the greater portion of the weight, at least according to the common mode of fixing them to the bottom of the carriage; the spring, therefore, being flexible, it would be still further depressed. But when the straps are oblique, the upper one assumes always the more vertical position, and consequently bears more of the load; for when a body of any kind is supported by two oblique forces, their horizontal thrusts must be equal, otherwise the body would move laterally; and in order that the horizontal portions of the forces may be equal, the more inclined to the horizon must be the greater: the upper spring will, therefore, be a little depressed, and the carriage will remain more nearly horizontal than if the springs were parallel. The reason for dividing the springs into separate plates has already been explained: the beam of the carriage, that unites the wheels, supplies the strength necessary for forming the communication between the axles: if the body of the carriage itself were to perform this office, the springs would require to be so strong that they could have little or no effect in equalizing the motion, and we should have a waggon instead of a coach. The ease with which a carriage moves, depends not only on the elasticity of the springs, but also on the small degree of stability of the equilibrium, of which we may judge in some measure, by tracing the path which the centre of gravity must describe, when the carriage swings.

There is an inconvenience which attends the usual method of loading carriages; for when a carriage is loaded equally heavy on both axles, the fore-axle must endure as much more friction, and consequently wear out as much sooner than the hind-axle, as the fore-wheels are less than the hind ones. However, the carriers commonly put the heavier part of the load upon the fore-axle of the waggons; which not only makes the friction greatest where it ought to be least, but also presseth the fore-wheels deeper into the ground than the hind-wheels, although the fore-wheels, being less than the hind ones, are with so much the greater difficulty drawn out of a hole, or over an obstacle, even supposing the weights on their axles were equal; for the difficulty, with equal weights, will be as the depth of the hole, or height of the obstacle, is to the semi-diameter of the wheel. Moreover, since a small wheel will often sink to the bottom of a hole, in which a great wheel will go but a very little way, the small wheels ought to be loaded with less weight than the great ones; and then the heavier part of the load would be less jolted upward and downward, and the horses tired so much the less, as their draught raised their load to less heights. When the waggon-road, indeed, is much up-hill, there may be danger in loading the hind-part much heavier than the fore-part; for then the weight would overhang the hind axle, especially if the load be high, and endanger tilting up the fore-wheels from the ground. In this case, the safest way would be to load it equally heavy on both axles; and then as much more of the weight would be thrown upon the hind axle than upon the fore one, as the ground rises from a level below the carriage. But as this seldom happens, a small temporary weight might be laid upon the pole between the horses, which would overbalance the danger.

From Mr. Ferguson's observations on the centre of gravity, it is evident, that if the axle-tree of a two-wheeled carriage passes through the centre of gravity of the load, the carriage will be in equilibrio in every position in which it can be placed with respect to the axle-tree; and

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in going up and down hill, the whole load will be sustained by the wheels, and will have no tendency either to press the horse to the ground, or to raise him from it. But if the centre of gravity is far above the axle-tree, as it must necessarily be according to the present construction of wheel-carriages, a great part of the load will be thrown on the back of the horses from the wheels, when going down a steep road, and thus tend to accelerate the motion of the carriage, which the animal is striving to prevent: while in ascending steep roads a part of the load will be thrown behind the wheels, and tend to raise the horse from the ground, when there is the greatest necessity for some weight on his back, to enable him to fix his feet on the earth, and overcome the great resistance which is occasioned by the steepness of the road. On the contrary, if the centre of gravity is below the axle, the horse will be pressed to the ground in going up-hill, and lifted from it when going down. In all these cases, therefore, where the centre of gravity is either in the axle-tree, or directly above or below it, the horse will bear no part of the load in level ground. In some situations, the animal will be lifted from the ground when there is the greatest necessity for his being pressed to it, and he will sometimes bear a great proportion of the load when he should rather be relieved from it.

The only way of remedying these evils, says Dr. Brewster, is to assign such a position to the centre of gravity, that the horse may bear some portion of the load when he must exert great force against it, that is, in level ground, and when he is ascending steep roads; for no animal can pull with its greatest effort, unless it is pressed to the ground. Now, this may in some measure be effected in the following manner:—Let *BCN* (Plate XL. fig. 12.) be the wheel of a cart, *A* *D* one of the shafts, *D* that part of it where the cart is suspended on the back of the horse, and *A* the axle-tree; then if the centre of gravity of the load is placed at *m*, a point equidistant from the two wheels, but below the line *DA*, and before the axle-tree, the horse will bear a certain weight on level ground, a greater weight when he is going up-hill, and has more occasion for it, and a less weight when he is going down-hill, and does not require to be pressed to the ground. All this will be evident from the figure, when we recollect that if the shaft *DA* is horizontal, the centre of gravity will press more upon the point of suspension *D* the nearer it comes to it; or the pressure upon *D*, or the horse's back, will be proportional to the distance of the centre of gravity from *A*. If *m* therefore be the centre of gravity, *bA* will represent its pressure upon *D*, when the shaft *DA* is horizontal. When the cart is ascending a steep road, *AH* will be the position of the shaft, the centre of gravity will be raised to *a*, and *aA* will be the pressure upon *D*. But if the cart is going down hill, *AC* will be the position of the shaft, the centre of gravity will be depressed to *n*, and *cA* will represent the pressure upon the horse's back. The weight sustained by the horse, therefore, is properly regulated by placing the centre of gravity at *m*. We have still, however, to determine the proper length of *ba* and *bm*, the distance of the centre of gravity from the axle, and from the horizontal line *DA*; but as these depend upon the nature and inclination of the roads, upon the length of the shaft *DA*, which varies with the size of the horse, on the magnitude of the load, and on other variable circumstances, it would be impossible to fix their value. If the load, along with the cart, weighs four hundred pounds, if the distance *DA* be eight feet, and if the horse should bear fifty pounds of the weight, then *bA* ought to be one foot, which being one-eighth of *DA*, will make the pressure upon *D* exactly fifty pounds. If the road slopes four inches in one foot,

b m must be four inches, or the angle *b A m* should be equal to the inclination of the road, for then the point *m* will rise to *a* when ascending such a road, and will press with its greatest force on the back of the horse.

When carts are not constructed in this manner, we may, in some degree, obtain the same end by judiciously disposing the load. Let us suppose that the centre of gravity is at *O* when the cart is loaded with homogeneous materials, such as sand, lime, &c. then if the load is to consist of heterogeneous substances, or bodies of different weight, we should place the heaviest at the bottom, and nearest the front, which will not only lower the point *O*, but will bring it forward, and nearer the proper position *m*. Part of the load, too, might be suspended below the fore-part of the carriage in dry weather, and the centre of gravity would approach still nearer the point *m*. When the point *m* is thus depressed, the weight on the horse is not only judiciously regulated, but the cart will be prevented from overturning, and in rugged roads the weight sustained by each wheel will be in a great degree equalized.

In loading four-wheeled carriages, great care should be taken not to throw much of the load upon the fore-wheels, as they would otherwise be forced deep into the ground, and require great force to pull them forward. In some modern carriages, this is very little attended to. The coachman's seat is sometimes enlarged so as to hold two persons, and all the baggage is generally placed in the front, directly above the wheels. By this means the greatest part of the load is upon the small wheels, and the draught becomes doubly severe for the poor animals, who must thus unnecessarily suffer for the ignorance and folly of man.

There is another great disadvantage attending small fore-wheels; *viz.* that as their axle is below the level of the horse's breasts, the horses not only have the loaded carriage to draw along, but also part of its weight to bear, which tires them sooner, and makes them grow much stiffer in their hams, than they would be if they drew on a level with the fore-axle; and for this reason, coach-horses soon become unfit for riding. So that on all accounts it is plain, that 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 them a fair draught, but likewise cause the machine to be drawn by a less degree of power.

Mr. Beighton disputes the propriety of fixing the line of traction on a level with the breast of a horse, and says it is contrary to reason and experience. Horses, he says, have little or no power to draw, but what they have from their weight; otherwise they could take no hold of the ground, and then they must slip, and draw nothing. Common experience also teaches, that if a horse is to convey a certain weight, he ought, that he may draw the better, to have a proportional weight on his back or shoulders. Besides, when a horse draws hard, he bends forward, and brings his breast near the ground; and then, if the wheels are high, he is pulling the carriage against the ground. A horse tackled in a waggon will draw two or three ton, because the point or line of traction is below his breast, by reason of the wheels being low. And it is very common to see, when one horse is drawing a heavy load, his fore-feet will rise from the ground; and he will nearly stand on end; in which case it is usual to add a weight on his back, to keep his fore-part down, by a person mounting on him, which will enable him to draw that load, without which he before could not move. The great stress, or main business of drawing, says this ingenious writer, is to overcome obstacles; for on level plains the drawing is but little, and then the horse's back need be pressed but with a small weight. Most or all of these obstacles may be considered

considered as inclined planes. In order to draw the wheel $A B$ (*Plate XL. Mechanics, fig. 13.*) over the obstacle D , M. de Camus, agreeably to the principles above laid down, would have the horse draw in the line $H C$; whereas Mr. Beighton says, since the obstacle is D , and the tangent of the earth, or line of the floor, is at B , and the line to be moved in is $B D$, an inclined plane; the easiest position of drawing, to get the wheel over D , is to draw in the position of that inclined plane $B T$, or its parallel $C b$. As all the radii of a wheel are equal, the pulling at the centre is the same as a balance in equilibrio; viz. there is the same force at A as at B . But in the case of drawing in the horizontal line $H C$, when the obstacle is at D , the whole force which the horse has for drawing is by the short end of the brachium $= e D$, against the force or weight of the long end of the brachium $f D = e C$, which must be very disadvantageous; therefore, he says, the line of traction should be $b C$. *Defag. Exp. Phil. vol. ii. App. p. 542, &c.*

Whilst M. Camus maintained that the line of traction should be an horizontal line, or always parallel to the ground on which the carriage is moving, 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 largest possible lever, M. Couplet, considering that the roads are never perfectly level, and that the wheels are constantly surmounting small eminences, even in the best roads, recommends the line of traction to be oblique to the horizon. It is, however, to M. Deparcieux (*Sur le Tirage des Chevaux, Mem. Acad. Roy., 1760.*), that we are principally indebted for just ideas on this subject. He has shewn in the most satisfactory manner that animals draw by their weight, and not by the force of their muscles. In four-footed animals, the hinder 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 effects. Thus in *Plate XL. Mechanics, fig. 12*, let P be the load, $D A$ the line of traction, and let us suppose $F C$ to be the hinder leg of the horse, $A F$ part of its body, A its chest or centre of gravity, and $C E$ the level road. Then $A F C$ will represent the crooked lever by which the horse acts, which is equivalent to the straight one $A C$. But when the horse's weight acts downwards at A , round C as a centre, so as to drag forward the rope $A D$, and raise the load P , $C E$ will represent the power of the lever in this position, or the lever of the horse's weight, and $C F$ the lever by which it is resisted by the load, or the lever of resistance. Now, if the horse lowers its centre of gravity A , which it always does when it pulls hard, it is evident that $C E$, the lever of its weight, will be increased, while $C F$, the lever of its resistance, will be diminished, for the line of traction $A D$ will approach nearer to $C E$. Hence we may see the great benefit which may be derived from large horses, for the lever $A C$ necessarily increases with their size, and their power is always proportioned to the length of this lever, their weight remaining the same. Large horses, therefore, and other animals, will draw more than small ones, even though they have less muscular force, and are unable to carry such a heavy burden. The force of the muscles tends only to make the horse carry continually forward his centre of gravity; or, in other words, the weight of the animal produces the draught, and the play and force of its muscles serve to continue it.

From these remarks, then, according to Dr. Brewster's statement, we may deduce the proper position of the

line of traction. When the line of traction is horizontal, as $A D$, the lever of resistance is $C F$; but if this line is oblique to the horizon, as $A d$, the lever of resistance is diminished to $C f$, while the lever of the horse's weight remains the same. Hence it appears, that inclined traces are much more advantageous than horizontal ones, as they uniformly diminish the resistance to be overcome. Deparcieux, however, has investigated experimentally the most favourable angle of inclination, and found, that when the angle $D A F$, made by the trace $A d$, and a horizontal line, is fourteen or fifteen degrees, the horses pulled with the greatest facility and force. This value of the angle of draught will require the height of the spring-tree bar, to which the traces are attached in four-wheeled carriages, to be one-half of the height of that part of the horse's breast to that with which the fore end of the traces is connected.

This height is about four feet six inches, and therefore the height of the spring-tree bar should be only two feet three inches, whereas it is generally three feet.

8. The utility of broad wheels, in amending and preserving the roads, has been so long and generally acknowledged, as to have occasioned several acts of the legislature to enforce their use. See TURNPIKE.

Several excellent and well-devised experiments have not long ago been instituted by Boulard and Margueron, which have satisfactorily evinced the distinguishing advantage of broad wheels. See a Memoir presented to the Academy of Lyons, in the *Journal de Physique*, tom. xix. p. 424.

Nevertheless, the proprietors and drivers of carriages seem to be convinced by experience, that a narrow-wheeled carriage is more easily and speedily drawn by the same number of horses than a broad-wheeled one of the same burthen. And though government allowed them to draw with more horses, and carry greater loads than usual, they were persuaded with difficulty to comply with the requisition of legislature; and methods have been used to evade it. Their principal objection has been, that as a broad wheel must touch the ground in many more points than a narrow wheel, the friction must of course be so much the greater; not considering, that if the whole weight of the waggon, and load in it, bears upon many points, each sustains a proportionable less degree of weight and friction than when it bears only upon a few points; so that what is wanting in one is made up in the other, and, therefore, will be just equal under equal degrees of weight, as appears by the following plain and easy experiment proposed by Mr. Ferguson.

Let one end of a piece of packthread be fastened to a brick, and the other end to a common scale for holding weights; then having laid the brick edgewise on a table, and letting the scale hang under the edge of the table, put as much weight into the scale as will just draw the brick along the table. Then taking the brick to its former place, lay it flat on the table, and leave it to be acted upon by the same weight in the scale as before, which will draw it along with the same ease as when it lay upon its edge. In the former case, the brick may be considered as a narrow wheel on the ground; and in the latter as a broad wheel. And since the brick is drawn along with equal ease, whether its broad side or narrow edge touches the table, it shews that a broad wheel might be drawn along the ground with the same ease as a narrow one, supposing them equally heavy, even though they should drag, and not roll as they go along. Besides, as narrow wheels are always sinking into the ground, especially when the heaviest part of the load lies upon them, they must be considered as constantly going up hill, even on level ground; and their edges must sustain much friction by rubbing

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rubbing against the sides of the ruts made by them. But both these inconveniences are avoided by broad wheels; which, instead of cutting and ploughing up the roads, roll them smooth, and harden them: though, after all, it must be confessed, that they will not do in stiff, clayey cros roads; because they would soon gather up as much clay as would be almost equal to the weight of an ordinary load; and also in passing along roads abounding with loose stones and other obstacles, which a narrow wheel may avoid passing over, and a broad one must surmount, the broad-wheel carriage will certainly be drawn less easily and less speedily than a narrow-wheeled one, though not on account of any additional friction arising from the pressure of the weight on a greater quantity of surface. Broad wheels are likewise more liable to an inequality of pressure between the axle and box than narrow ones, and consequently to a greater wear and tear.

Jacob's Obs. on the Structure and Draught of Wheel-Carriages, 1773, p. 81, &c. See on the subject of the preceding article, Defag. Ex. Phil. vol. i. p. 201, &c. Ferguson's Lect. p. 56, &c. 4to., and Appendix by Brewster. Martin's Phil. Brit. vol. i. p. 229, &c.

We shall here subjoin some additional remarks on wheels and axles for carriages. The essential qualities of wheels are strength and durability, and it is desirable that they should be as light as is consistent with strength: for quick travelling carriages lightness is very necessary.

Wheels to four-wheel carriages should be made as near of a height as the construction and appearance will admit; and if not required for heavy work, the lighter they are made the better. The fixtures from whence the draught is taken should be placed rather above the centre of the largest wheel, for advantage of draught.

The members of a wheel are of three descriptions; *viz.* the nave, or stock, which is the central piece; the spokes, or radii; and the fellies, or circumference. The nave or stock is made of elm, in which all the spokes are fixed, and in which the axletree-box, or wheel-box, is confined, to receive the axle-arms on which the wheel revolves. The spokes are straight timbers made of oak, firmly tenoned in the nave, in the direction of radials, to support the fellies, or wheel-rim. The fellies are made of ash, or beech, and form the rim of the wheel; the whole circumference is usually divided into short lengths, in the proportion of one length to every two spokes. When the fellies are fixed on the spokes, the iron band, or tire, which maintains the wear, is nailed on in lengths, and keeps the fellies together. The diameters of wheels regulate the number of spokes and fellies they are to contain: for the larger the circumference of the wheel is, the greater is the number of spokes required in proportion; for they should not in any wheel be more than fifteen inches distant on the fellies, or circumference.

The usual height or diameter of wheels for coaches and travelling carriages extends to five feet eight inches, and are divided into four proportions. Those which contain from eight to fourteen spokes, and only half that number of fellies, are called eights, tens, twelves, or fourteens, which are the number of spokes in such wheels, or of fellies in a pair of wheels. The height which regulates the number is, for an eight-spoke wheel, not to exceed three feet two inches; for a ten, four feet six inches; for a twelve, five feet four inches; for a fourteen, five feet eight inches.

These are the extreme heights for the different numbers of spokes to each wheel, which should be rather more than less, in particular for the fore-wheel of a four-wheel carriage, which receives more stress than the hind one; and the coachmaker's rule is, when the hind-wheels are of that height to

require fourteen spokes, the fore one, if under the necessary height before stated, should have twelve; never allowing the fore-wheels to have but two spokes less than what is needful for the hind ones.

There are three descriptions of wheels; *viz.* the straked, the hooped, and the patent rim: the differences of these are only in the rims.

The straked wheel is made with the fellies in separate lengths or pieces, which are joined together at the ends by dowels; that is, a round pin which enters part into one piece and part into the other, being closely fitted into holes made in each. The iron with which it is plated is called the strake, and is put on in pieces of the same length as the pieces of the fellies, and fastened by nails; the joints of the iron are made to fall over the middle of the pieces of wood so as to unite them firmly together. The hooped wheel is surrounded by a hoop of iron in one entire piece. The patent wheel is made with a hoop of wood in one entire piece, by boiling or softening the wood until it can be bent into a circle; this is surrounded by a hoop of iron in an entire piece, and fastened by nuts and rivets.

According to the usual method of constructing straked wheels, their peripheries are composed of a number of pieces or fellies joined together; but these are weak, and subject to several inconveniences. As the joints are the weakest parts of the wheel, they are most liable to yield inward; for which reason the wheelwrights leave them higher than the other parts of the rim, in consequence of which the wheel is not exactly round within the circle of the rim. Besides, the fellies being segments of a circle, sawed or hewn out of straight wood, they are on this account rendered so brittle, from the cross direction of the grain near the joints, that they are with difficulty kept together, even though almost twice the quantity of timber be employed that would otherwise be necessary. The strength of such a wheel depends on the thickness of the iron tire or rim that surrounds it, and hence the carriage is loaded with an useless weight, both of wood and iron. To obviate these inconveniences, Mr. Viny invented the process for bending timber into a circular form, practised for some time by Messrs. Jacob and Viny, and is now continued by others. In wheels made of timber thus bent, the rim consists either of a single piece of wood, or two fellies only, and is cased with a single hoop of iron. By this mode of construction, the grain of the wood is kept parallel throughout, so that the periphery of the wheel is every where equally strong; its thickness is considerably lessened, inasmuch that though little more than half the usual quantity of timber is employed, the wheel is of itself strong enough to sustain the common burthen laid on such wheels, without the assistance of iron tires, which are only applied to them as a safe-guard, to preserve the wood from the injuries to which it would otherwise be necessarily exposed from the roads; and hence a less quantity of iron is sufficient, and even that will be fairly worn out before it becomes useless. Besides, the wheel is rendered much lighter, and at the same time much stronger and more durable, than wheels constructed of detached pieces of wood and iron, in the usual manner. These patent wheels are very superior to the common sort, in their neat light appearance, and in the length of time they wear, as two sets of the former will wear as long as three of the latter: their preservation depends very much on the hoops that the wheels are rimmed with. Some persons still prefer the common sort of wheels, on account of their being more easily repaired than the hoop-wheel; but though the repairing of the latter is more difficult, they are much less subject to need it.

As the rims of wheels wear soonest at their edges, they should

should be made thinner in the middle, and fastened to the fellies with nails of such a kind, that their heads may not rise above the surface of the rim. The fellies on which the rims are fixed should, in carriages, be three inches and a quarter deep, and in waggons four inches. The naves should be thickest at the place where the spokes are inserted, and the holes in which the spokes are placed should not be bored quite through, as the greafe upon the axle-tree would insinuate itself between the spoke and the nave, and prevent that close adhesion which is necessary to the strength of the wheel.

The track in which the wheels of every carriage are to run is generally the same, except when intended for particular roads, where waggons and other heavy carriages are principally used, and leave very deep ruts, in which light carriages must likewise run, or be liable to accident, and are also sure to be heavy in draught. All four-wheel carriages should have the hind and fore wheels regulated to roll in the same track. The ordinary width of the wheels is four feet eight or ten inches; that of waggons or carts generally measure five feet two inches; chaise-wheels, as being principally intended for the country, are adapted to this width. It is immaterial to what width wheels are set if used for running upon stones; but on marshy roads, if their exactness is not attended to, the draught is considerably increased. We have seen a carriage of which the iron axle-tree is made in two pieces, overlapping each other in the middle where they are joined, and secured by proper bands to the wood-work of the carriage, so as to admit of sliding in the direction of the axle-tree. These parts are cut with teeth like racks, and a pinion is applied between them; so that by turning this pinion round, the two parts of the axle-tree are made to slide one upon the other; and the wheels which are fitted upon the two extreme ends of the axle-tree can at pleasure be fixed at greater or less distance, as the roads require.

The different heights of hind and fore wheels make also a difference in the length of their axle-trees, agreeable to the proportion they bear to one another; the fore-wheel has the longest axle-tree by one or two inches between the shoulders.

The nave of the wheel is pierced through the centre, with a large hole to introduce the box, or iron tube, for the axle-arm, as this tends to weaken the wood. It has been frequently proposed to make metal naves, or centre-pieces for wheels, which should contain the box for the axis, and the mortises for the spokes of the wheel all cast of one piece of metal. Messrs. Dodson and Skidmore had a patent for this in 1799. The objection to it is, that, if the wood of the spokes shrinks, they become loose in the mortises, whereas a wooden nave shrinks at the same time with the spoke. This defect has been since remedied by making the metal wheel-stock in two parts; one with recesses, or sockets, to contain the spokes, and the other a flat plate to fasten against the former with screw-bolts, and press the spokes into their cavities. Mr. Plucknet had a patent for a metal wheel-stock of this kind in 1805, which answered extremely well for carts, waggons, and artillery. The spokes were made to fill up all the space in the nave or stock, so that each spoke touched its neighbour. The metal stock was only a flat circular plate, or flanch, projecting from the box which received the axle, and another flat plate fitted upon it, and bound against the former by screw-bolts, one passing through each arm; these rendered the wheel very strong.

Mr. Wilks took a patent in 1813 for a metal stock, in which there are complete cells for each spoke, and the cells are dove-tailed; that is, they are made larger at the central part than at the outside, to prevent them from drawing out, and

they are firmly pressed into the dove-tails by the screw-bolts which confine the moveable plate.

Wheels for railway-waggons are made of cast-iron, and usually all in one piece; but this is objectionable, because the unequal contraction of the arms and rim of the wheel in cooling, after the wheel is cast, puts the different parts on a strain, and they frequently break without any adequate force. It is better to cast the rim in one piece and the arms in another, and put them together with screw-bolts, or rivets. Mr. Hawks had a patent for this in 1807. In this way, the rims may be replaced when worn out.

The Axle-trees for Wheels of Carriages.—The strong iron bar which extends across beneath the wood-work of the carriage, is called the axle-tree; the round parts at each end, on which the wheels run, are called the axle-arms; and the part or stem between them, which is fixed beneath the wood-work of the carriage, is also called the axle-tree. In the form of the latter parts there are but two sorts, the one made flat, and called a bedded axle-tree, it being sunk all its length in the under side of the timbers of the carriage; the other is made of an octagon form, and flat only at the ends where they are bedded.

The axle-arms on which the wheels turn should be made perfectly round, and somewhat stronger at the shoulder than at the extreme end, which is screwed to receive a nut, through which and the axle-tree the linch-pin passes, to keep all tight. The nuts are made with a collar at the face; and a temporary collar, or washer, is driven on the back of the arms, which form two shoulders for the wheel to wear against, and helps to preserve the greafe from running out, and to prevent dirt from getting in.

As the axle-trees are the principal or only support of the carriage, every attention and care should be fixed in the selection of good iron; and to see that they be well wrought, and of sufficient strength, rather going to the extreme of strength, than risking the life of the passenger by the over-setting of the carriage, which mostly happens when an axle-tree breaks.

By the bend of the axle-trees, the wheels are regulated to any width at bottom, to suit the track of the roads in which they are to run, and are confined in the carriage by means of clips, hoops, and bolts. The shape of the axle-tree between the shoulders varies according to the situation they are placed in, or the form of the timber of the carriage with which they are united; those are the most firm that are flat, bedded in the timber. Axle-tree boxes for wheels are of various kinds; those which are frequently called long-pipe, or wheel-boxes, are long tubes fitted accurately to the arms of the axle-trees, and securely fixed in the wheel-stocks, or naves; they are usually made of wrought sheet-iron of a substance proportioned to the weight of the carriage; their use is to contain a supply of greafe, and to prevent the effects of friction, whereby the wheels are much assisted in their motion. These are now used instead of the old cast-iron boxes, which for quick travelling-carriages are totally out of use, being found injurious to the axle-trees, by cutting them at those parts they wear against, so as to occasion a frequent lining of the arms; but with the wrought metal boxes this is seldom necessary.

There are many sorts of axle-trees and boxes invented various ways, with a view of attaining the following advantages; *viz.* To contain a longer supply of greafe or oil, to be more durable, to secure the wheels, and to lessen the draught. Those are all certainly great advantages, and though the expence is great, the utility of either of them must be more than adequate to it, and merits more general notice.

Some of these inventors even pretend that all these advantages are combined in one axle-tree; but the generality extend to the advantage only of retaining a supply of oil, and remaining perfect to a considerable length of time. The common sort of axle-tree and box, which is most generally used, is simple and cheap in comparison with the others.

Common Axle-tree.—The arms of the axle-tree are made round, but rather of a conical form, strongest at the back or shoulders, tapering to the lynch end, which is screwed for a nut, and also has a small hole for a lynch-pin, which prevents the nut from coming off; at the body-end is a washer or collar for the back of the wheel-stock to wear against. The box is made of sheet-iron, proportioned in substance to the weight or size of the axle-tree, having the edges of the plate, of which it is formed, welded in a ridge which projects on the outside; this secures the box in the nave of the wheel, and prevents it turning round therein.

The nut which screws on the end of the axle-arm has a broad face to lie flat against the wheel, and is tapped or screwed to receive the screw-end of the axle-tree. Each of those nuts must turn on the screw the same way the wheel goes, and must have a notch for the lynch-pin to pass through, for the purpose of securing the nut from turning off.

The box is what, of the axle-tree, wears most, and is frequently obliged to be refitted to the arms; otherwise they give to the wheel while in use an unsteady motion, and soon exhaust their stock of grease.

Those that are well fitted will contain their supply for about one week with regular use, or a journey of one hundred miles. They wear at the rate of one set of boxes to every two sets of wheels, and require in that time to be twice or thrice taken out of the wheels and refitted to the axle-tree arms.

Axle-trees with Friction-Wheels.—These were invented by Mr. Garnet, at least the best kind, which are made in a very ingenious manner. The wheel-box is made much larger than the axle-tree, in such manner that the space all round between them may receive a number of rollers which fill it up. (See a description in the article *MILL-Work*.) Mr. Garnet had a patent in 1784, and for some years manufactured great numbers; but being very expensive, they fell into disuse, although very complete. This invention has been lately revived by Mr. Panter.

The Patent Anti-Abrition Axle-tree and Box.—The proposed advantages of this axle-tree are, ease of draft by diminution of friction; the retention of oil to supply a month's use; the ease with which it is replenished without taking off the wheels; the great security for the wheels, which it prevents from coming off, and the carriage from overturning, if even the arm of the axle-tree should break; and their durability, and even improvement by wear. Those axle-trees, if made with the securing-collar, for the wheels need no nut or lynch-pin, as is generally used, but the wheel may be taken off and put on as easily as those on the common principle.

These axle-arms are reduced at the bottom from a perfect round, and grooved, to receive two small rollers, on which the weight of the carriage is borne, and which greatly facilitates the motion, in the same manner as blocks of stone or timber, which require to be removed by the assistance of rollers. These rollers form the outer circumference of the axle-trees at bottom, which are reduced to give a bearing only on them. A circular box or cistern is provided to contain a supply of oil; it is closely fitted to the back of the inner end of the wheel-stock, and fixed by three bolts. The oil is here contained within three circular recesses, and

oozes through small channels on the arm of the axle-tree, which it feeds for a considerable time. This oil-box is made of cast-metal, and has a cap projecting behind over the axle-tree, which prevents the dirt from getting into the box. This axle-tree is also provided with what is called the wheel-security, or strap-washer. It is an iron collar, fitted on the external part of the wheel-stock, and confined between the reservoir and stock, lying as it were in a groove, so that the collar cannot come off. This collar has two lugs or straps extending backwards some distance along that part of the axle-tree which is bedded in the wood-work, where it is fixed by a nut-screw. By means of this strap-washer, the wheel is secured to the bedded part of the axle-tree; and should the axle-arm within the wheel break, the wheel will continue to act.

The cap of this axle-tree is also fixed on the outside part of the wheel-stocks; by the same three bolts which fasten the oil-box, and by means of a screw-plug in the cap, the axle-tree and reservoir are replenished with oil. The box is of the same form as the common box, only made of a very hard durable metal, of a considerable thickness, and is made in proportion to the weight of the carriage.

Collinge's Patent Cylinder Axle-tree and Box.—These axle-trees have been a considerable time in use, and their advantages have been proved in the length of time they wear, in the silent and steady motion they preserve to the wheels, in the advantage of retaining the oil to prosecute a journey of two thousand miles without being once replenished; and lastly, they are very durable, and but little subject to be out of order.

The axle-tree arm is made as perfectly cylindrical as possible, and of a peculiar hard substance; the middle of the cylinder is reduced, to contain the oil necessary to feed the axle-trees; so that the two bearings are at the two ends of the axle, which has an internal shoulder, against which the inner end of the wheel-box takes its bearings. Behind this shoulder is a deep groove for a washer to preserve the oil, and prevent noise in its use; also a rim, or hollow box, on the collar of the axle-tree, which overlaps part of the inner end of the wheel-stock to keep out dirt, and answer the use of a cuttoo. The extreme end of the arm is double-screwed, to receive two nuts for securing the wheel: the one screw turns the way of the wheel; the other the reverse, and is meant as an additional security.

The box is made of a very hard metal, nicely polished, and fitted to the arms, having a circular recess all round at the end nearest the carriage, for containing there a supply of oil. The box is longer than the part which bears on the axle; and the projecting part beyond the bearing at each end is bored out larger than the arm. The back projection fits close to the rim of the collar, which it covers: the fore one projects outwards beyond the surface of the wheel-stock, and is screwed on the inside to receive the screw of the cap.

There are many other patents for axle-trees to wheels; but as few of them have come into use, we shall only notice Messrs. Flight and Brook's patent axles. The axle is fixed fast to the nave of the wheel, by passing through it. This axle turns round within the wheel-box; whereas in others the wheel-box turns round upon the axle.

The axle is cylindrical, and is received into a cylindrical box or tube in the end of the iron axle-tree, which is firmly bolted to the under-side of the timber of the carriage. To hold the axle in its place, and prevent it from drawing out of the box, the end of the axle is reduced to a knob or button, which adheres to the end of the axle by a small neck.

neck. This button is fitted and received into a socket, in which it can freely turn round, but cannot draw out endways. It is made in a piece of metal, which is cylindrical on the outside, and of the same size as the axle. It is made in two halves, which separate longitudinally to introduce or take out the button at the end of the axle; but when the two halves are put together, the socket-piece forms as it were a continuation of the axle. When the axle is put into the box with this socket-piece at the end of it, the two halves of the socket will be confined together, so that they cannot separate; and to prevent them from drawing out of the box, a screw-bolt is put through the box, and passes through both halves of the socket: this holds the socket and the axle in their places.

Mr. Ackermann has recently obtained a patent (1818) for a valuable improvement in the application of the fore-wheels to four-wheeled carriages. In our article *COACH-MAKING*, vol. viii. we have described those methods which were then known of applying the fore-wheels, so as to make a four-wheel carriage turn with safety, and in a small space. See also *PERCH*.

Mr. Ackermann's improvement effects this in the most perfect manner. Each of the fore axle-trees is connected with the carriage by means of a vertical axle, formed in the same piece with the horizontal axle, and upon which the wheel turns, the two axles being situated at right angles to each other. These vertical axles are fitted into sockets, formed at the two extremities of a cross beam of the frame of the carriage, which is called the fore-spring transom. Upon these axles, as centres of motion, the axle-arms and wheels can be turned about horizontally, in order to place them obliquely to the direction of the hinder-wheels when the carriage is required to turn; but each axle turns upon a separate centre of motion, and these centres are very near to their respective wheels, being at the extremities of the cross-beam or transom; hence the fore-wheels do not change their place upon the ground when they are placed obliquely.

In a common carriage, the axles of the two fore-wheels are both fixed to one piece of timber, called the axle-bed, which is placed beneath the fore-transom, and united to it by a vertical pin called the perch-bolt, passing through the middle of the axle-bed. On this pin, as a centre, the axle-bed is turned round. When the wheels are to be placed obliquely, it is evident, that, in so turning upon a single centre, one wheel must advance forwards, and the other must retreat backwards, so as to diminish the bearing of the carriage-wheels on the ground in a lateral direction, and at the same time the horses are pulling in that direction which tends to overturn the carriage. Another inconvenience is, that one of the wheels will touch the perch of the carriage, if placed very oblique.

In the new improvement, two separate centres of motion being used, and these being removed from each other as far as possible, many desirable properties are attained.

To give the oblique direction to the wheels, each vertical axle has a lever proceeding backwards from it; and these two levers are united together by a connecting-bar, which obliges both axles to move at the same time with a sympathetic action. The pole of the carriage is united to the piece, called the futchel, in the usual manner; and the futchel is united to the spring-transom by a perch-bolt, in the usual position; also the hinder end of the futchel is jointed to the middle of the connecting-bar, between the two levers of the vertical axles. The connecting-bar likewise answers the purpose of a sway-bar.

When the horses move to one side, the pole and futchel

turn upon the perch-bolt, as a lever upon a centre of motion; and the extreme end of the futchel acts upon both vertical axles at once by means of the connecting-bar, so as to place both of the fore-wheels in an oblique direction. This is the invention of M. Lankensperger of Munich.

WHEEL, Aristotle's. See *ROTA Aristotelica*.

WHEEL, Blowing, a machine contrived by Dr. Defagulier for drawing out the foul air of any place, or for forcing in fresh, or doing both successively, without opening doors or windows. See *Phil. Transf. N^o 437*.

The intention of this machine is the same as that of Dr. Hales's ventilator, but not so effectual, nor so convenient. See *Defagul. Course of Exper. Philos. vol. ii. p. 563. 568*.

This wheel is also called a *centrifugal wheel*, because it drives the air with a centrifugal force.

WHEELS, Bushes or Boxes of, the inside metal linings of the naves. See *WHEEL*.

WHEEL, Cutting Roller, in Agriculture, a tool of the cutting and reducing sort, used for the purpose of working over crops in some cases. In Oxfordshire a cutting roller of this sort has been invented, which is composed of twelve wheels, two inches and a half in thickness; and between each of them is a space of two inches and a half. They are three feet in diameter. It is a load in working so as to be sufficient exertion for a strong team to draw it: it is passed over wheat after it has been sown, or after it is come up; and if dry, crops and crops. It has also been used in the spring upon wheat; it leaves the surface rough in a sort of diamond forms, which is found very beneficial in some of the wheat-lands of that district. It is also capable of being used in breaking down the surface of stiff tillage-land in many other cases and circumstances.

WHEEL, Draining, a wheel constructed for the purpose of cutting or making drains. Wheels differently formed are used for this sort of work. In Essex they employ workmen who make use of a cast-iron wheel which weighs about four hundred weight, and which is four feet in diameter; the cutting edge or extreme circumference of the wheel being half an inch in thickness, which increases in this way as it approaches towards the nave or centre; and will, at fifteen inches deep, scour out or cut a drain half an inch wide at the bottom, and four inches wide at the top. The wheel is so placed in a frame, that it may be loaded at pleasure, and be made to pass to a greater or less depth, as the nature of the land may be.

The writer of the Middlesex Report on Agriculture advises the use of a common six-inch cart-wheel, on the felly of which, all round, a sort of ridge-formed addition of wood is to be fixed, and a rim of iron of a triangular shape fastened to the wood. A wheel of this kind put on the axle of a cart, in the usual way, will, of course, rest on the edge of the rim of iron; and which, on driving the horse forward, will make a small indent or depression in the ground merely by the revolution of it; but in order to make it press down to the depth of six or eight inches, that side of the cart should be loaded with stones, iron ballast, or any other heavy material that may happen to be at hand, until the whole of the parts, if necessary, sink into the soil. It would however be as well, or better, it is said, if the rim parts added to the wheel were in one piece of cast-iron; as the increased weight of it would enable it to cut or sink without the aid of ballast, or with less than usual. The cart should then be drawn along in such a manner, that the cutting or depressing wheel may revolve where the drains are intended to be made. In land that is in ridges and furrows, it will sometimes be necessary to draw the wheel along every furrow.

furrow. When the ground is without ridge and furrow, the wheel should be drawn over it in parallel lines, five or ten yards distant from each other. The wheel on the other end of the axle is a common six-inch wheel, supporting only the empty side of the cart, consequently will not cut or depress the ground.

The advantage of this contrivance is, that it makes an indent or depression in the surface soil of soft wet clayey grasslands, sufficient to carry off the water during the same winter, by pressing down the sward and herbage without destroying it. In the following spring, these drains will be nearly grown up, and clothed with grass; consequently, there will be nothing taken from the pasturage or the scythe. It is necessary to observe, that the wheel must be drawn over the ground every year on the approach of winter. With it, and two old horses, a stout boy or man may, it is said, drain from ten to twenty acres in eight hours.

It may be found very useful in the grass and hay land districts about the metropolis and other places. See SURFACE Draining.

WHEEL, *Measuring*. See PERAMBULATOR.

WHEEL, *Orffyreus's*. See ORFFYREUS.

WHEEL, *Persian*. See PERSIAN.

WHEEL-Ploughs, in *Agriculture*, all such ploughs as are constructed with wheels. See PLOUGH.

WHEEL, *Potter's*, is a round board attached to a lathe, and capable of being moved by it, either rapidly or more slowly, as occasion may require. This round board moves in a horizontal position; and when in use, the clay which is to be fashioned is fixed on the centre of it; and it is put in motion either by a person who constantly attends it when at work, or by means of a treadle which is moved by the foot of the workman himself.

As the clay revolves upon this machine, the workman either models it by his fingers, or forms it, by means of an instrument which he holds in his hand, into any kind of circular shape that he may desire; and when the object is to make a number of vessels exactly similar to each other, the size is generally determined by a gauge fixed without the circumference of the revolving wheel, but projecting over it in such a manner that, whenever the yielding clay is spread out until it touch this gauge, the artist knows that the article which he is making has attained the exact figure which he intends.

The potter's wheel has lately been much improved by adapting a strap to it, which passes over a large taper cylinder of wood, and by means of which the artist is enabled to increase or diminish the rapidity of the motion at pleasure. This contrivance is known to mechanics by the name of the *cone pulley*. Parkes's *Essays*, vol. iii. See POTTERY.

WHEELS, *Tires of*, the iron hoops or bars which are put round the outsides of the felly-parts of them.

WHEEL, *Water*. See WATER.

WHEEL is also a name of a kind of punishment, which great criminals are put to in divers countries.

In France, their assassins, parricides, and robbers on the highway, were condemned to the wheel; *i. e.* had their bones first broken with an iron bar on a scaffold, and then to be exposed and left to expire on the circumference of a wheel. In Germany, they broke their bones first on the wheel itself.

This cruel punishment was unknown to the ancients; as is observed by Cujas. It is not certain who was the inventor. Its first introduction was in Germany. It was, indeed, but rarely practised any where else, till the time of Francis I. of France; who, by an edict of the year 1534, appointed

it to be inflicted on robbers on the highway. Richelet dates the edict in the year 1538, and quotes Brodæus, *Miscell.* lib. ii. cap. 10.

WHEEL, in the *Military Art*, is the word of command, when a battalion or squadron is to alter its front, either one way, or the other.

To wheel to the right, the man in the right angle is to turn very slowly, and every one to wheel from the left to the right, regarding him as their centre; and *vice versa*, when they are to *wheel to the left*.

When a division of men are on the march, if the word be, *wheel to the right*, or *to the left*; then the right or left-hand man keeps his ground, turning only on his heel, and the rest of the rank move about quick, till they make an even line with the said right or left-hand man.

Squadrons of horse wheel after much the same manner.

In wheeling, the circle is conceived to be divided into four parts; whence wheeling to the right or left respects only a quarter of a circle; and wheeling to the right or left about, refers to half of the circle. In performing this motion, each man moves more quickly or slowly, according to his distance from the right to the left. See BATTALION.

WHEEL, or *Catherine-Wheel*, in *Architecture*, frequently occurs in the upper part of the north and south transepts of our ancient cathedrals, being divided by mullions, like the spokes of a wheel: it resembles the engine of torture said to have been prepared by the tyrant Maximin to tear the flesh of St. Catherine of Alexandria. The French, who have generally placed a large wheel of this sort by way of a western window to their cathedrals, call it *Rose du Portail*.

WHEEL-Animals, *Brachionus*, in *Zoology*, a genus of animalcules, which have an apparatus of arms for taking their prey. (See BRACHIONUS.) This apparatus has been supposed, by microscopical writers, to be a kind of wheels. This is one of the smaller animalcules; and is described by Dr. Hill to be, when at rest, of a plain smooth body, conic figure, obtuse at the posterior extremity, and open at the anterior, of a dusky olive colour, and semi-transparent. When in motion it protrudes from the open extremity a part of its naked body, to the whole of which this outer conic body seems to be but a case or sheath; from the end of this exerted part of the body, it thrusts out two protuberances, which give it the appearance of a double head; and in each of these is discovered an apparatus in continual motion, appearing to be a rotatory one, though really a vibratory one very quickly repeated. Each of these protruded bodies has six arms inserted into it, which it continually shuts and opens over one another. Each of the arms is furnished with a double series of fibres at its edge, which, being expanded, cause it to spread to considerable breadth. There are several species of this genus.

The wheel animal, described by Mr. Baker, has two seeming wheels, with a great many teeth or notches coming from its head, and turning round as it were on an axis. On the least touch, this animalcule draws its wheel into its body into the sheath; but when every thing is quiet, throws them out and works them again.

In order to find these animalcules, choose such roots of duck-weed as are long, and proceed from strong old plants, for the young roots seldom afford any; they should not be covered with that rough matter which is frequently found about them, nor any way tending to decay, as they will often be.

In the water found remaining in the leaden pipes, or gutters on the tops of houses, there are also found great

numbers of these wheel-animals. These are of a different species from the former; and when the water dries away, they contract their bodies into a globular or oval figure, and are then of a reddish colour, and remain mixed with the dirt, growing together in a lump as hard as clay. This, whenever it is put in water, in half an hour's time discovers the animals' living again, and as brisk as ever; and they have been found to be living in this manner, after the matter had been kept dry twenty months.

It should seem from this, that as the water dries up, their pores become shut in the manner of those of such animals as remain torpid for the winter; and that when they find water come on again from rain, they then unfold themselves, and live and feed as long as it lasts. Baker's Microscope.

WHEEL-Barometer. See BAROMETER.

WHEEL-Boats denote a sort of boats with wheels, to be used alternately on the water and upon inclined planes or rail-ways.

WHEEL-Fire, among *Chemists*, a fire used for calcining metallic substances; properly called *ignis rotæ*.

It is a fire which only encompasses the crucible, coppel, or melting-pot, around the sides, without touching it in any part.

WHEEL-Shaped, in *Botany*, a term exclusively appropriated to the *corolla*. See ROTATA.

WHEELER, among *Brickmakers*. See BRICK.

WHEELER, in *Geography*, a river of Wales, which runs into the Clyde, 3 miles N. of Denbigh.

WHEELING, a post-town of Virginia, at the union of Wheeling Creek with the Ohio; 54 miles S.W. of Pittsburgh.—Also, a township of Ohio, in the county of Belmont, with 656 inhabitants.

WHEELING Creek, a river of Virginia, which runs into the Ohio, N. lat. 39° 56'. W. long. 80° 45'.

WHEELING Planks are stout planks which the navigators or workmen upon a canal make use of to wheel upon.

WHEELOCK, in *Geography*, a township of Vermont, in the county of Caledonia, containing 963 inhabitants; 60 miles N. of Windfor.—Also, a river of Cheshire, which runs into the Dane.

WHEELWRIGHT GUT, a creek on the north-west coast of the island of St. Christopher, with a bar before its entrance.

WHEEZING and *BLOWING*, in *Animals*, a sort of affection in the breathing, especially in horses, in which they draw their breath with difficulty and noise.

The generality of people make this and purfines, in horses, the same distemper; but the more judicious always distinguish it, as wholly different from that. Purfines proceeds always from a stuffing or oppression of the lungs; but this wheezing is only owing to the narrowness of the passage between the bones and gristles of the nose.

The horses that are most of all afflicted with this distemper do not want wind; for notwithstanding that they wheeze excessively when they are exercised, yet all the time their flanks are not moved, but kept in the same condition that they were when the creature stood still. The dealers call this sort of horses blowers, and though there is no real harm in the thing, it is a disagreeable quality, and few people will choose them that have much service for them.

There are some horses which have a natural defect in their breathing, which makes it at all times attended with some difficulty, but not with the wheezing before mentioned; these are called thick-winded horses.

People who are careful in the buying of horses, will purchase neither of these kinds; but there is this caution to be observed in regard to this defect, that it often seems to be in horses where it really is not. When a horse has been kept a long time in the stable without exercise, he will at the first riding be out of breath, and fetch it in a difficult and painful manner, though he be neither a blower nor thick-winded; but all this will go off with a little exercise.

There are some temporary wheezers and blowers among horses: these at times rattle, and make a great noise through their noses in taking breath; but the complaint goes off and returns. This is only occasioned by a great quantity of phlegm, for their flanks do not redouble with it at the worst of times, nor have they any cough with it; so that there is no danger of their being purfy.

It is probable, that in these cases there is, for the most part, some sort of spasm or constriction in the chests of the animals, as they are much relieved in most instances by the use of warm mashes, and by having their fodder made moist.

How far remedies that remove spasm might be useful has not yet been fully tried, either in these or other sorts of animals.

WHELDY-AHAD LAKE, in *Geography*, a lake of North America. N. lat. 61° 40'. W. long. 103° 30'.

WHELERA, in *Botany*, was so named by Schreber, in memory of the celebrated English traveller and botanist, sir George Wheler, Bart. F.R.S. who died in 1724, aged 74. His "Journey into Greece," however faulty in the plates, is a book of the first authority.—Schreb. Gen. 725.—Class and order, *Polygamia Monœcia*, Schreb.; rather *Pentandria Monogynia*. Nat. Ord. *Sapotæ*, Juss.

Gen. Ch. *Cal.* Perianth inferior, of one leaf, in five deep, roundish, erect, permanent segments, shorter than the corolla. *Cor.* of one petal, bell-shaped, spreading, in five deep, ovate, acute segments. Nectary somewhat pitcher-shaped, in the bottom of the flower. *Stam.* Filaments five, awl-shaped, rather longer than the corolla; anthers roundish. There are five other filaments, alternate with the former, and similar to them, but shorter, and destitute of anthers. *Pist.* Germen superior, conical, villos; style thread-shaped, twice the length of the corolla; stigma simple. *Peric.* Drupa roundish. *Seed.* Nut large, ovate, of one, two, or three cells.

Some flowers, on the same plant, want the pistil, others the stamens.

This is Schreber's generic description, from which we learn, without difficulty, the natural order of the plant. But it is one of those genera, like his *VILLARIA*, (see that article,) which cannot be determined without an examination of the author's herbarium. Such also are his *MEYERA*, already described; his *WOLFIA*, and *XYSTRIS*, which will occur hereafter. We trust some botanist, who may have the opportunity of clearing up these, the only important obscurities in Schreber's classical work, will favour the world with an explanation of them. *SPARTINA* is in the same predicament, except that professor Schrader appears to be acquainted with it. See that article.

WHELKS, *Buccina*, in *Natural History*. See SHELLS, and TRUMPET-Shell.

WHELPS. See HOUND.

WHELPS, in a *Ship*. See CAPSTAN.

WHENNUIA, in *Geography*, a small island among those called the Society islands, near Otaha.

WHERLICOTES, a sort of open chariots, of the ancient Britons' invention, used by persons of quality before the invention of coaches.

WHERN,

WHERN, in *Natural History*, a name given by some of our miners to a kind of stone found in strata, but of the hardness and fineness of flint. It is called also *chert* and *nicomia*.

WHERRY. See **VESSEL, BOAT, &c.**

WHERRY, in *Rural Economy*, a provincial term applied to a liquor made from the pulp of crabs after the verjuice is expressed. It has not unfrequently the name of crab-werry. See **VERJUICE**.

WHERWELL, in *Geography*, a village of England, in the county of Hants. Here was formerly a convent of nuns, founded by Elfrida, widow of king Edgar, to expiate the murder of her first husband, Ethelwolf, and her son-in-law, prince Edward; 4 miles S. of Andover.

WHET-SLATE, or **WHETSTONE-SLATE**, and **HONE**, French *novaculite*, and *schiste coticule*, in *Mineralogy*, a variety of slate used for sharpening iron and steel instruments. (See **SLATE**.) The light green coloured variety from the Levant is considered as the most valuable. It is brought in masses to Marseilles, and is there cut into pieces of various sizes, and afterwards ground with sand or sand-stone, and then polished with pumice and tripoli. These whet-stones or hones should be kept in damp places, for when much exposed to the sun, they become too hard and dry for many purposes. The powder of whet-slate is used for cutting and polishing metals, and is by artists considered as a variety of emery. It is necessary to the perfection of hones, that they should contain no intermixed substances, such as quartz, &c. (Jamefon's *Mineralogy*, second edition, vol. i.) Whet-slate, approaching in appearance to foreign hones, occurs in the upper part of Long Sleddale, in Westmoreland; and at Howth, in Dublin bay.

WHET-STONE, in *Rural Economy*, the soft stone usually made use of in sharpening edge-tools of different kinds.

WHEWER, in *Ornithology*, a name used in some parts of England for the common wigeon. See **DUCK**.

WHEY, the serum, or watery part of milk.

In many disorders of the human body, where the stomach will not bear milk, or when it is not proper, for other reasons, whey may be given with great success.

We have a dissertation of Fred. Hoffmann on this subject, *De Saluberrima feri Lactis Virtute*. Oper. tom. vi. p. 9. This author recommends a particular kind of serum or whey, made by evaporating milk to a dryness, and mixing the residuum with water. See **MILK**.

There are various methods of making whey, vulgarly known. That with oranges is very agreeable, and much recommended by Dr. Cheyne, in his *Nat. Method of curing Diseases*.

WHEY, in *Rural Economy*, a term applied to the serous part of milk, from which the curd has been separated. There are two sorts or colours of whey, the green and white; the latter is by much the richer, and that which chiefly affords the butter of this kind. See **DAIRYING**.

WHEY, Alum, Serum Aluminosum, a whey made with alum; in the proportion of two drachms of alum to one pint of cow's milk boiled.

This whey is beneficial in an immoderate flow of the menses, and in a diabetes, or excessive discharge of urine. The dose is two, three, or four ounces, as the stomach will bear it, three times a day.

WHEY-Butter, that which is made from the cream of whey. It is commonly made in abundance in the dairy districts after cheese-making begins. See **DAIRYING**.

WHEY-Cream, that which is collected from off the whey

and made into butter of this sort. A dairy cow usually affords eight or ten ounces of it weekly in some dairies. See **DAIRYING**.

WHEY, Mustard, is made by boiling of bruised mustard-seed, an ounce and a half, in milk and water, of each a pint, till the curd is perfectly separated, and straining the whey through a cloth. This, says Dr. Buchan, is the most elegant, and by no means the least efficacious method of exhibiting mustard: it warms and invigorates the habit, and promotes the different secretions. Hence, in the low state of nervous fevers, it will often supply the place of wine: it is also of use in the chronic rheumatism, palsy, dropfy, &c. The dose is a tea-cupful four or five times a day, which may be sweetened with a little sugar.

WHEY, Scalding of, the heating of it and pouring it over the curd in making cheese.

WHEY, Scorbutic, is made by boiling half a pint of the scorbutic juices, in a quart of cow's milk. The scorbutic plants are, bitter oranges, brook-lime, garden scurvy-grass, and water-cresses.

WHEY Springy Cheese, the eyeey spongy cheese of this sort, caused by being improperly made.

WHEY-Tub, the vessel in which the whey stands for yielding the cream, &c.

WHICHCOTE, BENJAMIN, in *Biography*, an eminent divine of the English church, was born in March 1609-10, of an ancient family at Whichcote-hall, in Shropshire; and having finished his education at Emanuel college, Cambridge, in 1626, he passed through the common degrees, and became fellow of his college in 1633, and a distinguished tutor. In 1636 he took orders, and established a lecture at Trinity church, in Cambridge, and continued it for nearly twenty years. It was his great object to substitute a spirit of sober and rational piety in the university, instead of the enthusiasm and fanaticism which then prevailed; nor were his efforts for this purpose unavailing. Being married, and having settled on a living in Somersetshire, his connection with the university was for some time interrupted; but in 1644 he returned to it, as the successor of Dr. Samuel Collins, the ejected provost of King's college, allowing to him part of the emoluments that belonged to this office. In 1649 he took the degree of D.D., and was presented to the rectory of Milton, in Cambridgeshire. He is represented by bishop Burnet as a friend to liberty of conscience, and in order to promote rational and sublime ideas of religion, he advised the students to peruse the ancient philosophers, especially Plato, Cicero, and Plotinus. At the Restoration he was deprived of his provostship, and removing to London, he was chosen minister of St. Anne's, Blackfriars, in 1662. Afterwards, when his church was burnt down, he retired to Milton, but he was recalled to London to the vicarage of St. Lawrence, Jewry, by presentation from the crown; and he served this church with great reputation till his death in 1683.

After his death, a volume of his "Select Sermons," 8vo. 1698, was published, with a preface by lord Shaftesbury, author of the "Characteristics," by whom they were valued, because the author recognized that sense of the beauty of virtue which is the foundation of his moral system. Two more volumes were afterwards published by Dr. Jeffery, archdeacon of Norwich, who, in 1703, presented to the public "Moral and Religious Aphorisms collected from Dr. Whichcote's MS. Papers." A fourth volume was published by Dr. S. Clarke in 1707, and reprinted in 1753 by Dr. Salter, with large additions, and eight letters between the author and some of his friends on important subjects.

These several publications assigned to Dr. Whichcote a high rank among the rational divines of this country, and particularly at the period in which he lived. Biog. Brit.

WHICKS, in *Agriculture*, a term sometimes applied to young plants of the white-thorn kind, as well as to couch-grass. See QUICKS and COUCH.

WHIDAH, in *Geography*, a kingdom of Africa, on the Slave Coast; extending about ten miles along the coast, and about seven miles into the land. Europeans who have been in Whidah speak of the country with rapture, and extol it as one of the most beautiful in the world. The trees are straight, tall, and disposed in the most regular order, which present to the eye fine long groves and avenues, clear of all brush-wood and weeds. The verdure of the meadows, the richness of the fields, clothed with three different kinds of corn, beans, roots, and fruits, and the multitude of houses, form a most delightful prospect. A perpetual spring and autumn succeed each other; for no sooner has the husbandman cut his corn, than he again ploughs and sows the ground; yet it is not worn out; the next crop puts forth with the same vigour as the former, as if nature here were inexhaustible. Certain it is, that the kingdom of Whidah is so populous, that one single village contains as many inhabitants as several entire kingdoms on the coast of Guinea; and yet they stand so close, that one is amazed how the most fertile land on earth can supply the number of people contained in so small a compass. One may compare the whole kingdom to a great city, divided by gardens, lawns, and groves, instead of streets, the villages in Whidah not being a musket-shot distant from each other. Some are the king's, some the viceroy's villages, and others are built and peopled by particular private families. The former are the largest and best built; but the latter the best cultivated, if there be any difference in a country so uniformly rich and beautiful. Notwithstanding the small extent of this kingdom, it is divided into twenty-six provinces, which take their names from the capital towns. Those small states are distributed among the chief lords of the kingdom, and become hereditary in their families. The king of Whidah, who is only their chief, presides particularly in the province of Sabi, or Xabier, which is the principal province of the kingdom, as the city of the same name is the capital of the whole. Bujis, which the French by corruption call bauges, pass frequently for money at their fairs in the country: this is a small white shell, of the size and shape of an olive. In the kingdom of Whidah and Ardra, these bujis serve equally for dress and money, for ornament and use. They pierce each shell with an iron made for that purpose; forty of them they string upon a cord, which they call *seuze*, and the Portuguese *toquos*: five of these strings compose what the Portuguese call a *gallinba*, and the Negroes a *fore*. By these the exchange of gold-dust is rated, and the price of slaves determined. The Europeans, the nobility of Whidah, and all the rich negroes, are carried, when they go abroad, in hammocs, or palanquins, on the shoulders of slaves. The natives of Whidah are in general tall, well made, straight, and robust. Their complexion is black, but not so glossy as that of the people on the Gold Coast, and still less than those of Senegal and the river Gambia. They excel all other negroes in industry and vigilance. Idleness is the favourite vice of the Africans in general; here, on the contrary, both sexes are so laborious and diligent, that they never desist till they have finished their undertaking; carrying the same spirit of perseverance into every action of their life. Besides agriculture, from which none but the king and a few persons of the first distinction are exempted, they employ

themselves in several kinds of manufactures: they spin cotton-yarn, weave fine cotton cloths, make calabasses, wooden vessels, plates, and dishes; likewise assagayes, and smiths'-work in greater perfection than any other people on the coast. Whilst the men are thus employed, the women brew pito, and dress provisions, which, with their husbands' merchandize, they carry for sale to market. As to religion, Bosman is of opinion, that the piety of this country is founded upon no other principles than those of interest and superstition. In the latter, they exceed all other nations; for allowing, says he, the ancient heathens to value themselves upon thirty thousand deities, I dare venture to affirm that the natives of Whidah may lay just claim to four times that number. However, he believes that they have a faint idea of the one true God, to whom they attribute omnipotence and ubiquity. One of their principal fetiches, or deities, is the snake, which they invoke in extreme wet, dry, or barren seasons, on all occasions relating to their government, civil policy, and cattle; in a word, on all the great difficulties and occurrences of life. This snake has a large round head, beautiful piercing eyes, a short pointed tongue, resembling a dart: its pace slow and solemn, except when it seizes on its prey, then quick and rapid; its tail sharp and short, its skin of an elegant smoothness, adorned with beautiful colours, upon a light-grey ground. It is amazingly tame and familiar, permitting itself to be approached, and even handled: they have a mortal antipathy to all venomous serpents: they attack them wherever they find them, as if they had pleasure in delivering mankind from their poison. The Europeans find no difficulty in familiarizing themselves to these inoffensive animals, with which they play without any dread or apprehension of danger. There is no fear of mistaking them for the poisonous serpents, the colour and size sufficiently distinguishing them. The negroes entertain a notion that the first progenitor of this race of snakes is still living, and growing to an enormous bulk. When the English first settled in Whidah, the captain having unshipped his goods on shore, the sailors found at night one of those snakes in their magazine, which they ignorantly killed, and threw upon the bank, without dreaming of any bad consequences. The negroes, who soon discovered the sacrilege, and had it confirmed by the acknowledgment of the English mariners, were not long in avenging the horrid impiety, by a method no less horrible. All the inhabitants of the province assembled; they attacked the English, massacred them all to a man, and consumed their bodies and goods in the fire they had set to the warehouse. Animals of all kinds are punished with death for injuring a snake. In 1697, a hog having had the presumption to destroy one of these deities, an order was issued for a general slaughter of swine throughout the kingdom, and the destruction of the whole race was hardly prevented by the interposition of the king.

WHIDAH, a town of Africa, in the country of Whidah. N. lat. $6^{\circ} 25'$. E. long. $1^{\circ} 24'$.

WHIDBY'S ISLAND, an island in the Gulf of Georgia, near the west coast of America; about 36 miles long, and from 2 to 6 broad: so named from Mr. Whidby, an officer under captain Vancouver. N. lat. $48^{\circ} 10'$. E. long. $237^{\circ} 40'$.

WHIDDY, an island in Bantry bay, in the county of Cork, Ireland, about 2 miles from the town of Bantry. It is a pleasant island of a triangular form, and the soil is excellent.

WHIFF, in *Ichthyology*, the name of a sort of flounder. WHIFFLER of a *Company*, in London, a young free-

man,

man, who goes before, and waits on the company, on occasions of public solemnities.

WHIG, in *Rural Economy*, a term provincially applied to acidulated whey, which is sometimes mixed with butter-milk and sweet herbs, to give it a flavour, when it becomes a good cooling summer beverage.

WHIGS, a party or faction in England, opposite to the Tories.

The origin of the names of these two mighty factions is very obscure. If some little trivial circumstance or adventure, which escapes the knowledge of mankind, gives name to a party, which afterwards becomes famous, posterity labours in vain to find the original of such a name: it searches the sources, forms conjectures, invents reasons, and sometimes, indeed, meets the truth, but always without knowing it assuredly.

Thus, in France, the Calvinists are called Huguenots; yet nobody was ever able certainly to assign the cause of that appellation.

Whig is a Scottish, and, some say too, an Irish word, literally signifying *whey*. *Tory* is another Irish word, signifying a *robber* or *highwayman*.

Under the reign of king Charles II., while his brother, then duke of York, was obliged to retire into Scotland, there were two parties formed in that country. That of the duke was strongest, persecuted the other, and frequently reduced them to fly into the mountains and woods; where those unhappy fugitives had often no other subsistence for a long time but cows' milk. Hence they called these their adversaries *tories*, *q. d. robbers*; and the tories, upbraiding them with their unhappiness, from the milk on which they lived, called them *whigs*. From Scotland, the two names came over with the duke into England.

Others give a different origin and etymology of the two words, for which see **TORIES**.

Bishop Burnet gives another etymology of the term *whigs*. The south-west counties of Scotland, he says, are supplied with corn from Leith; and from a word *whiggam*, used by the carriers in driving their horses, all that drove were called *whiggamoors*, and by contraction *whigs*.

He adds, that in the year 1648, after the news of the defeat of duke Hamilton, who was charged with being a confederate with the malignants, or royal party, in England, the ministers animated their people to rise, and march to Edinburgh: who came up, marching each at the head of his parish, with an unheard-of fury, praying and preaching all the way as they came. The marquis of Argyll and his party came and headed them. This was called the *whiggamoor's* inroad; and ever after, all that opposed the court were contemptuously called *whigs*: and from Scotland the term was brought into England. Burnet's Hist. of his Own Times, vol. i. p. 43.

For the distinguishing principles and characters of the whigs, see **TORIES**.

WHIMBRAL. See **SCOLOPAX** *Guarauna*, and **PHÆOPUS**.

WHIMSEY, WATER, a machine consisting of a reservoir, or bucket of water, employed for raising another bucket, filled with coals or other materials, by means of a rope or chain, coiled round a cylinder or drum, or two drums of different sizes. When the bucket of water in this machine has reached the bottom of the pit or well, a valve is opened by striking against a pin, and lets out the water. In a machine of this kind, used in the duke of Bridgewater's coal-works, the water descends thirty yards, and raises a smaller quantity of coals from a depth of sixty. In such cases, supposing the action to be single, and the stream of water to

be unemployed during the descent of the reservoir, a considerable preponderance may be advantageously employed in giving velocity to the weights, provided that the machinery be not liable to injury from their impulse.

WHIN, in *Botany*. See **GORSE**.

WHIN, in *Agriculture*, a term sometimes applied to furze; which, when cut in the sap and bruised in a proper way by flails, or in other modes, makes an excellent green food in winter for horses, which eat and thrive on it well. It is also useful in some measure to sheep-stock, as well as to bees. Its encroaches on land may be easily and readily prevented by proper means being taken for the purpose. See **FURZE**.

WHIN, in *Gardening*. See **ULEX**.

WHIN-Ashes, in *Agriculture* and *Planting*, the ashes produced in burning whins; which have lately been found of great benefit in planting young trees, as well as on land for other purposes, promoting their growth in a very high degree. If the land to be planted be suitable, they are advised to be carefully spread and ploughed in, if of quantity sufficient, over the whole field, otherwise only on the wet or colder spots or parts of it. But if the ground be such that it will not admit of ploughing, the ashes should be mixed up with part of the best surface mould, to keep them from blowing abroad; and in the process of pitting, a little of this compost should be intimately mixed with the mould of each pit; previously distributing it in small heaps at convenient distances for facilitating the operation: and this extra trouble will be amply repaid by the progress the plants will make in consequence.

WHIN-Axe, in *Agriculture*, an instrument employed for extirpating whins from laud in many cases. It is an implement that has one end like a common axe, with four inches of face; and the other like an adze, also with four inches of face; whereby the person using it, continuing in the same position by simply turning it in the hand, can make cuts at right angles with one another, as circumstances may require. The head of the tool may be about eight inches in length, weighing from three to four pounds; and the handle, of ash, about four feet long.

WHIN, Petty, a name given to a species of *ononis*, or rest-harrow.

WHIN, Petty, in *Gardening*. See **GENISTA**.

WHINCHAT, in *Ornithology*, the English name of the *motacilla rubetra* of Linnæus.

It is of the common size of the water-wagtail. Its head, neck, and back, are of a reddish-brown, with regular rows of black spots. Over each eye is a narrow white stroke, and beneath that a broad bed of black, extending from the bill to the hind part of the head; the breast is of a reddish-yellow; the belly paler; the quill-feathers are brown, edged with a yellowish-brown; the upper part of the wing is marked with two white spots; the lower part of the tail is white, the two middle feathers excepted, which are wholly black; the upper part of the other is of the same colour.

The colours are very uncertain in this bird, and it often much resembles the stone-chatter; but may always, by an accurate observer, be distinguished from that bird by the white spots in its wings, by the whiteness of the under part of its tail, and the white lines on its head.

The colours of the female are much less agreeable than those of the male; in lieu of the white and black marks on the cheeks is one broad pale brown one; and the white on the wings is in much less quantity than that of the male.

In the north of England, the whinchat is a bird of passage;

fage; in the fourth he continues the whole year. Ray and Pennant.

WHINE, a hunting term, used in respect of the cry of an otter.

WHINEBACH, in *Geography*, a town of Africa, on the Gold Coast. N. lat. $5^{\circ} 30'$. W. long. $1^{\circ} 30'$.

WHIN-STONE, in *Geology*, the provincial name given, in many parts of England and Scotland, to basaltic rocks: it is also applied by miners to designate every kind of dark-coloured and hard unstratified rock, which resists the point of the pick. Many geologists in this country class all basaltic or trap rocks under the term whin-stone. See **TRAP**.

The substance which fills very large mineral veins is generally dark basalt, or green-stone; hence these veins are most frequently called whin-dykes. These veins being harder than most of the rocks which they intersect, remain when the surface on each side of them is washed away, forming enormous walls extending into the sea, or rising above the level of the country in various parts of their course, and may often be traced for many leagues. They occur in the counties of Northumberland and Durham, and on the coasts of Scotland; and when broken down, they form reefs of rock or islands. The Farn islands, off the coast of Northumberland, are parts of a basaltic dyke. When whin-dykes cross rivers, they form ledges of rock constituting fords; or, if very abrupt, they hold up the water on one side and form cascades. The Cleveland basalt, or whin-dyke, described in Mr. Bakewell's *Introduction to Geology*, (see **VEINS, Mineral**;) has been traced from the coast of Yorkshire seventy miles into the western part of Durham.

Under the article *Mineral VEINS*, we have observed, that when whin-dykes intersect coal strata, they produce a change in the substance of the coal, and also of the other strata, similar to what might have been expected from a stream of melted lava; and we have recently observed a similar effect produced on primitive rocks of gneiss, in the vicinity of Aberdeen, by contact with a powerful whin-dyke. The whin-stone is also changed near its contact with the gneiss into a reddish horn-stone. In other parts, it is a dark granular basalt or green-stone. The gneiss has lost its characteristic structure, and becomes porphyritic when near the whin-dyke. Between whin-dykes and the rocks which they intersect, there is sometimes a seam of soft argillaceous earth interposed, which is washed out when they are near the sea-coast, leaving the whin-stone like a wall placed between two perpendicular precipices. Sometimes the internal part of a whin-dyke will be composed of soft iron-clay; in other instances, the dyke will be composed of solid blocks or prisms of basalt separated by similar clay. In some whin-dykes, the substance which fills them appears a compact and solid mass of whin-stone, which, however, will divide into four, five, or six-sided prisms, arranged horizontally.

These are perfectly similar to the perpendicular basaltic columns in structure, differing only in their position. There is a dyke traversing the basaltic strata of the Giant's Causeway, on the coast of Antrim, in which this peculiarity of structure is remarkably displayed. It intersects beds of columnar basalt, in which the columns are arranged with great regularity, and are perpendicular to the horizon; but the whole dyke is composed of small prisms of basalt placed horizontally, or at right angles with the former. Some of these prisms do not exceed an inch in diameter, others are much larger; they are for the most part extremely regular, and are articulated or jointed.

It has been supposed with much probability, that the different arrangement of the columnar structure in the beds and in the dyke, is to be attributed to the different circum-

stances under which they were solidified. If the beds have once flowed as lava under the surface of the ocean, the basalt would begin to cool and crystallize from the upper and lower surface. That this has probably been the case may be inferred from these beds resting on strata that contain marine organic remains, and which must, therefore, have been formed under the bed of the ocean.

The perpendicular dykes intersecting rocks already formed would begin to cool from the sides with which they were in contact, and the process would proceed laterally.

In some instances, we find whin-dykes principally composed of globular masses of stone separated by a large quantity of soft clay, and the globular masses are incrustated with ochreous clay: probably the whole of the clay in such dykes has been formed from the decomposition of the basaltic masses by the action of water percolating them.

Whin-stone dykes present so many analogies with volcanic rocks in their composition, and the effects which they produce on the strata that they pass through, that we are led to refer their origin to the action of subterranean fire cracking the upper rocks and strata, and forcing the melted matter into the rent. Under the article **VOLCANO**, we have stated many instances of vast rents made in the earth, and filled by eruptions of lava; these rents so filled with lava may be considered as whin-dykes of recent formation. This is further confirmed by the observations of M. Cordier, (see **VOLCANIC Productions**;) who has shewn that the substance which fills both are essentially the same, being principally composed of feldspar and augite, with iron-sand and olivine. Whin-stone not only occupies the cavities of perpendicular dykes; but it appears to have been, in many instances, found laterally between the regular strata, producing singular contortions and dislocations, and almost always effecting a change in the substance of the rock with which it comes in contact. Sometimes it produces a change in the form of the bed or stratum which it has passed through, breaking it into distinct masses, or bending it in different directions, or enveloping large parts of it in the basalt or whin-stone. Of this a remarkable instance is described in the third volume of the *Transactions of the Geological Society*, occurring on the north coast of Ireland, in the county of Antrim. (See *Plate IV. fig. 4. Geology.*) *aaa* represents a bed of chalk singularly bent, and completely enveloped in the basalt which forms a part of the basaltic range extending from the Giant's Causeway.

The beds of chalk and the other strata on this coast are frequently intersected by whin-dykes, and a most remarkable change is observed in the structure of the chalk in the vicinity of these dykes. In immediate contact with the whin-stone, and to a considerable distance on each side, the chalk is converted into marble, having the granular texture of primitive lime-stone, or what the French call *calcaire saccharoide*, from its resemblance to the grain of loaf-sugar, (see *Plate IV. fig. 5. Geology*;) which represents two adjoining whin-dykes *ab*, intersecting the chalk *ccc*; the dyke *a* is thirty feet in width, the dyke *b* twenty feet, and the intervening mass of chalk twenty feet. The mass of chalk between the two large dykes is intersected in a zigzag direction by a smaller dyke. To a certain distance from the whin-stone, the chalk is perfectly crystalline, but it gradually approaches to the character of the chalk at a greater distance from the dyke. In various parts of the world we observe trap or whin-stone occurring in apparently regular beds, either covering stratified rocks, or interposed between them; such have been called by the Wernerian geologists *stætz* trap-rocks, and their occurrence in this position has been urged as an argument for the aqueous formation of such

such rocks. But it is well known to practical miners, that these beds are much more variable in their thickness than the regular strata, sometimes measuring twenty, thirty, or forty feet or more; and in other parts, the same bed will diminish to a few feet, or entirely terminate. In the isle of Skye, according to the description of Dr. Maccullock, in the third and fourth volumes of the Transactions of the Geological Society, the whin-stone is spread over the regular strata in beds, or forms detached conical caps. It is also to be seen interposed between the strata, and may be traced for more than a mile in continuous regular beds; but, says Dr. Maccullock, "there are no instances but where the alternating beds of trap detach veins or dykes from the lower to the upper beds; or the trap, quitting the interval between two given beds of lime-stone or sand-stone, makes its way across the one immediately above or below, and then proceeds with a regularity as great between some other pair of proximate strata." And he adds, "I have no doubt, could such extensive exposure of the strata be oftener procured, all the instances of supposed alternating trap with regular stratified rocks would prove similar to the above." These observations, which might be confirmed by numerous other instances, tend to prove, that whin-dykes, and many of the interposed strata of whin-stone, are of posterior formation to the rocks in which they occur, and have been forced between the strata in a fluid state, and subsequently consolidated. The whin-dykes, or perpendicular veins, are the channels through which the basalt flowed up; but by superincumbent pressure, it has been driven laterally at different elevations. As beds of whin-stone occur in different rocks, it is probable, and almost certain, that they have had different epochs of formation; and of course some of the beds of whin-stone, which are covered by stratified rocks containing many organic remains, may have flowed as beds of lava under the ocean, and have been again covered with other strata, on which again a second torrent of lava bursting from below may have flown and formed an upper bed. It is well known that the beds of toad-stone in Derbyshire, which are interposed between the mountain lime-stone of that district, cut off the metallic veins; but they are found again on sinking through the toad-stone into the lower lime-stone. This stone, which varies from a hard, compact whin-stone or trap, to a soft amygdaloidal wacke, (see *TOAD-STONE* and *WACKE*,) is supposed, by Mr. Whitehurst, to have flowed between the beds of lime-stone after the formation of metallic veins; and, could we admit the hypothesis, it would satisfactorily explain the cause of their disappearance in the toad-stone. But though there are many instances of the vein entirely disappearing in the latter rock, there are others in which a narrow vein passes through the toad-stone, though it is never productive of ore, being filled with calcareous spar, and a few particles only of galene. The occurrence of these veins in the toad-stone proves that this rock was not found between the lime-stone after the formation of metallic veins. Some softer whin-stone rocks, of the species called by mineralogists wacke, (see *WACKE*,) contain cavities lined, or partly filled with zeolites, agates, or calcareous spar; and some of these rocks envelope marine organic remains, particularly a rock of this kind near Berkley in Gloucestershire. The Euganean mountains are composed of a similar rock, and also contain marine remains. These rocks have probably been formed by muddy eruptions of submarine volcanoes, similar to what take place from some of the American volcanoes at the present time; and it is not improbable but that these two modes of formation may have given rise to that diversity which we observe in rocks of this class, the softer and more earthy being the products of

aqueous and muddy eruptions, and the harder and more crystalline the products of igneous fusion. See *TRAP*, and *VOLCANIC PRODUCTS*.

WHIP, or **WHIP-STAFF**, in a *Ship*, a piece of timber in form of a strong staff, fastened into the helm, for the steersman, in small ships, to hold in his hand; thereby to move the rudder, and direct the ship.

WHIP denotes also a sort of small tackle, formed by the communication of a rope either with a single immovable block, or with two blocks, one of which is fixed, and the other moveable. It is generally used to hoist light bodies, as empty casks, &c. out of a ship's hold, which is accordingly called whipping them up. *Falconer*.

To whip is to tie a piece of pack-thread, spun-yarn, &c. about the end of a rope, to prevent it from being untwisted and unloosened.

WHIP, in *Rural Economy*, the lash attached to flexible rods or other substances and contrivances, for the purpose of driving teams.

WHIP-GRAFTING, in *Gardening*, a particular mode of performing the operation. A sort of root-whip-grafting is advised by *Agricola*, in which a graft or scion is taken from a young tree, and a small piece of the root of another tree of the same kind, or like it; or otherwise, pieces of roots cut off from other trees in transplanting: these are whip-grafted together, taking care that the two but ends of the graft and root be united, and that the rind of the root join that of the graft; then plant the root with the part of the scion under-ground. See *GRAFTING*, and *STOCKS*, *Apple-grafting in*.

WHIP-POOR-WILL. See *CAPRIMULGUS Virginianus*.

WHIP-REIN, in *Agriculture*, a term used to signify a rein formed of cord or leather, by which a plough or other sort of team is directed in working. See *REIN*.

WHIP-REIN-PLOUGH, a term applied to a small plough, drawn by two horses, or oxen, which are guided and directed by proper reins of this sort, and so made as to serve the ploughman in the way of a whip, in driving them while he holds the plough.

WHIP-SAW. See *WHIP-SAW*.

WHIPLADE, in *Husbandry*, a term used by the farmers in some places for a particular sort of cart, whose hinder part is made up of boards after the manner of a dung-cart, having also a head of boards, and shambles over the thills; this head being so as either to be taken out or left in. The cart may be indifferently used to carry dung or other things; dung when the head is in, and corn, &c. when it is taken out.

WHIPPANY, in *Geography*, a town of New Jersey; 20 miles W.N.W. of New York.

WHIPPER. See *FISHING*.

WHIPPING, a term used by *Anglers*, when they fasten a line to the hook or rod.

The word is also taken for the casting in of the hook, and drawing it gently on the water.

WHIPPING, in *Law*, denotes an ignominious punishment inflicted on persons guilty of petty larceny, &c.

WHIPPING WHEAT, in *Agriculture*, a term applied to the practice in some of the northern districts, by which the wheat-crops are lashed or whipped out on a wooden or watted frame-work contrived for the purpose. The former is constructed by nailing two or more thick boards in a slanting manner, to the height of about two and a half, or three feet, on a sort of frame of suitable strength, supported by legs, having the upper part a little rounded, and made smooth. This, which is termed the whipping or lashing frame, is placed

placed in some convenient situation, so as to prevent the grain from flying about during the operation, which is then begun. Where the latter contrivance is made use of, the frame is woven with strong sticks, in the manner of a hurdle, being placed in the same situation when used.

The process is performed by taking large handfuls of the corn in the straw by the butt end, and striking the top or ear-ends over the upper part of the frame, so as to force out the grain from the ears of the top part, without breaking the straw, which in this way becomes much better for thatch, and at the same time the grain is less injured than by the flail method of threshing it out. The butt parts of the straw are sometimes afterwards thrashed over, in order to get out any wheat that may have been left in the short ears. This is an excellent mode of providing seed-wheat, as the finest grain is chiefly procured.

And it is suggested, too, as a particularly good method in cases where wheat is infected with the smut, as during the operation of threshing, the flail breaks the smut-balls, and reduces them to a powdery state, which causes the good wheat to have a blacker appearance than would otherwise be the case when ground. It may likewise be used to advantage with other sorts of grain in some cases.

The above is also a term sometimes applied in the northern districts, to the practice of striking it over a stone or other such contrivance, in order to get out the grain, and leave the straw in an unbroken state. In this way it is sometimes termed *lashing*. It is an excellent practice in getting out this sort of grain in many points of view, when on a small scale, but it is not well suited to large concerns. See **THRESHING**.

WHIPPLE-TREE, a term used to signify the bar or wooden part of the contrivance by which a horse or team is attached to a plough, harrow, or any other sort of implement of these kinds. They are of different sizes and forms, according to the nature of the teams and other circumstances. See **SWINGLE-TREE**, *Indented*.

WHIPSTITCH, a term not unfrequently used in ploughing to signify a sort of half-ploughing, or what in many places is termed *raftering*. It is principally made use of for keeping the land more dry and healthy in the winter season. See **RAFTERING**.

WHIPSTITCHING, the practice of working tillage-land in somewhat the raftering manner. It is a method often employed for turning up stubbles of the wheat and other kinds in the winter time, instead of making a fallow. The best mode of doing it in this intention is first to make what is called a whipstitch, rafter, or sort of half-ploughing of the land; and that when come back again to the same furrow, to turn them both over; the top parts of both furrows being thus turned in the middle, which leaves the space of four inches betwixt each furrow: then ploughing the land across the old furrows. If land lies ever so wet in winter, by ploughing in this manner, it may be kept dry and in a healthy state. It is necessary, too, to strike up the old furrows every day before leaving the ground; and to let the main drains be kept well open to receive the water from the furrows in the land: by this means, the frost will be admitted four inches deeper than in the case of a flat fallow-work.

This mode of tillage is that which is sometimes called double whipstitching in some districts and places.

Some prefer it before all other methods for winter-tillage, as it brings the land into much better condition for cultivation than twice fallowing.

WHIPT SYLLABUB. See **SYLLABUB**.

WHIRL-POOL, an eddy, vortex, or gulf, where the

water is continually turning round. See **GULPH**, **EDDY**, **VORTEX**, &c.

These in rivers are very common, from various accidents, and are usually very trivial, and of little consequence. In the sea they are more rare, but more dangerous. Sibbald has related the effects of a remarkable marine whirlpool among the Orcades, which would prove very dangerous to strangers, though it is of no consequence to the people who are used to it. This is not fixed to any particular place, but appears in various parts of the limits of the sea among those islands. Wherever it appears, it is very furious, and boats, &c. would inevitably be drawn in and perish with it; but the people who navigate them are prepared for it, and always carry an empty vessel, a log of wood, or large bundle of straw, or some such thing, in the boat with them; as soon as they perceive the whirlpool, they toss this within its vortex, keeping themselves out; this substance, whatever it be, is immediately received in the centre, and carried under water; and as soon as this is done, the surface of the place where the whirl-pool becomes smooth, and they row over it with safety; and in about an hour they see the vortex begin again in some other place, usually at about a mile distant from the first. Sibbald's *Prodr. Hist. Scot.*

WHIRLIGIG, in *Military Antiquities*, an instrument of punishment formerly much used for trifling offences, committed by petit cutlers, Jews, brawling women, and such persons. This was a kind of circular wooden cage, which turned on a pivot; and when set in motion, whirled round with such an amazing velocity, that the delinquent became extremely sick, and commonly made discharges through every operation of the body.

WHIRLING-TABLE, a machine contrived for exhibiting and demonstrating the principal laws of gravitation, and of the planetary motions in curvilinear orbits. *AA* (*Plate XXI. fig. 13. Astronomy*) is a strong frame of wood, *B* a winch fixed on the axis *C* of the wheel *D*, round which is the catgut-string *F*, which also goes round the small wheels *G* and *K*, crossing between them and the great wheel *D*. On the upper end of the axis of the wheel *G*, above the frame, is fixed the round board *d*, to which may be occasionally fixed the bearer *MSX*. On the axis of the wheel *H* is fixed the bearer *NTZ*, and when the winch *B* is turned, the wheels and bearers are put into a whirling motion. Each bearer has two wires, *WX* and *YZ*, fixed and screwed tight into them at the ends by nuts on the outside; and when the nuts are unscrewed, the wires may be drawn out in order to change the balls *U*, *V*, which slide upon the wires by means of brass loops fixed into the balls, and preventing their touching the wood below them. Through each ball there passes a silk line, which is fixed to it at any length from the centre of the bearer to its end by a nut-screw at the top of the ball; the shank of the screw going into the centre of the ball, and pressing the line against the under side of the hole which it goes through. The line goes from the ball, and under a small pulley fixed in the middle of the bearer; then up through a socket in the round plate (*S* and *T*) in the middle of each bearer; then through a slit in the middle of a square top (*O* and *P*) of each tower, and going over a small pulley on the top comes down again the same way, and is at last fastened to the upper end of the socket fixed in the middle of the round plate above-mentioned. Each of these plates, *S* and *T*, has four round holes near their edges, by which they slide up and down upon the wires which make the corner of each tower. The balls and plates being thus connected, each by its particular line, it is plain that if the balls be drawn outward, or towards the ends *M* and *N* of their respective bearers,

WHIRLING-TABLE.

bearers, the round plates S and T will be drawn up to the top of their respective towers O and P.

There are several brass weights, some of two, some of three, and others of four ounces, to be occasionally put within the towers O and P, upon the round plates S and T; each weight having a round hole in the middle of it, for going upon the fockets or axes of the plates, and being slit from the edge to the hole, that it may slip over the line which comes from each ball to its respective plate.

For a specimen of the experiments which may be made with this machine, we shall subjoin the following.

1. Removing the bearer M X, put the loop of the line b , to which the ivory ball a is fastened, over a pin in the centre of the board d , and turn the winch B; and the ball will not immediately begin to move with the board, but, on account of its inactivity, endeavour to remain in its state of rest. But when the ball has acquired the same velocity with the board, it will remain upon the same part of the board, having no relative motion upon it. However, if the board be suddenly stopped, the ball will continue to revolve upon it, until the friction thereof stops its motion; so that matter resists every change of state, from that of rest to that of motion, and *vice versa*.

2. Put a longer cord to this ball; let it down through the hollow axis of the bearer M X and wheel G, and fix a weight to the end of the cord below the machine; and this weight, if left at liberty, will draw the ball from the edge of the whirling-board to its centre. Draw off the ball a little from its centre, and turn the winch; then the ball will go round and round with the board, and gradually fly farther from the centre, raising up the weight below the machine; and thus it appears that all bodies revolving in circles, have a tendency to fly off from these circles, and must be retained in them by some power proceeding from or tending to the centre of motion. Stop the machine, and the ball will continue to revolve for some time upon the board; but as the friction gradually stops its motion, the weight acting upon it will bring it nearer and nearer to the centre in every revolution, till it brings it quite thither. Hence it appears, that if the planets met with any resistance in going round the sun, its attractive power would bring them nearer and nearer to it in every revolution, till they fell into it.

3. Take hold of the cord below the machine with one hand, and with the other throw the ball upon the round board as it were at right angles to the cord, and it will revolve upon the board. Then, observing the velocity of its motion, pull the cord below the machine, and thus bring the ball nearer the centre of the board, and the ball will be seen to revolve with an increasing velocity, as it approaches the centre: and thus the planets which are nearest the sun perform quicker revolutions than those which are more remote, and move with greater velocity in every part of their respective circles.

4. Remove the ball a , and apply the bearer M X, whose centre of motion is in its middle at w , directly over the centre of the whirling-board d . Then put two balls (V and U) of equal weights upon their bearing wires, and having fixed them at equal distances from their respective centres of motion w and x upon their silk cords, by the screw-nuts, put equal weights in the towers O and P. Lastly, put the catgut-strings E and F upon the grooves G and H of the small wheels, which, being of equal diameters, will give equal velocities to the bearers above, when the winch B is turned; and the balls U and V will fly off toward M and N, and raise the weights in the towers at the same instant. This shews, that when bodies of equal quantities of matter

revolve in equal circles with equal velocities, their centrifugal forces are equal.

5. Take away these equal balls, and put a ball of six ounces into the bearer M X, at a sixth part of the distance wz from the centre, and put a ball of one ounce into the opposite bearer, at the whole distance $xy = wz$; and fix the balls at these distances on their cords, by the screw-nuts at the top: then the ball U, which is six times as heavy as the ball V, will be at only a sixth part of the distance from its centre of motion; and consequently will revolve in a circle of only a sixth part of the circumference of the circle in which V revolves. Let equal weights be put into the towers, and the winch be turned; which (as the catgut-string is on equal wheels below) will cause the balls to revolve in equal times: but V will move six times as fast as U, because it revolves in a circle of six times its radius, and both the weights in the towers will rise at once. Hence it appears, that the centrifugal forces of revolving bodies are in direct proportion to their quantities of matter multiplied into their respective velocities, or into their distances from the centres of their respective circles.

If these two balls be fixed at equal distances from their respective centres of motion, they will move with equal velocities; and if the tower O has six times as much weight put into it as the tower P has, the balls will raise their weights exactly at the same moment: *i. e.* the ball U, being six times as heavy as the ball V, has six times as much centrifugal force in describing an equal circle with an equal velocity.

6. Let two balls, U and V, of equal weights be fixed on their cords at equal distances from their respective centres of motion w and x ; and let the catgut-string E be put round the wheel K (whose circumference is only half that of the wheel H or G) and over the pulley s to keep it tight, and let four times as much weight be put into the tower P, as in the tower O. Then turn the winch B, and the ball V will revolve twice as fast as the ball U in a circle of the same diameter, because they are equi-distant from the centres of the circles in which they revolve; and the weights in the towers will both rise at the same instant, which shews that a double velocity in the same circle will exactly balance a quadruple power of attraction in the centre of the circle: for the weights in the towers may be considered as the attractive forces in the centres, acting upon the revolving balls; which, moving in equal circles, are as if they both moved in the same circle. Whence it appears, that if bodies of equal weights revolve in equal circles with unequal velocities, their centrifugal forces are as the squares of the velocities.

7. The catgut-string remaining as before, let the distance of the ball V from the centre x be equal to 2 of the divisions on its bearer; and the distance of the ball U from the centre w be 3 and a sixth part; the balls themselves being equally heavy, and V making two revolutions by turning the winch, whilst U makes one; so that if we suppose the ball V to revolve in one moment, the ball U will revolve in two moments, the squares of which are 1 and 4: therefore, the square of the period of V is contained 4 times in the square of the period of U. But the distance of V is 2, the cube of which is 8, and the distance of U is $3\frac{1}{6}$, the cube of which is 32 very nearly, in which 8 is contained 4 times: and therefore the squares of the periods of V and U are to one another as the cubes of their distances from x and w , the centres of their respective circles. And if the weight in the tower O be 4 ounces, equal to the square of 2, the distance of V from the centre x ; and the weight in the tower P be 10 ounces, nearly equal to the square of $3\frac{1}{6}$, the distance

distance of U from w ; it will be found, upon turning the machine by the winch, that the balls U and V will raise their respective weights at very nearly the same instant of time. This experiment confirms the famous proposition of Kepler, *viz.* that the squares of the periodical times of the planets round the sun are in proportion as the cubes of their distances from him; and that the sun's attraction is inversely as the square of the distance from his centre.

8. Take off the string E from the wheels D and H, and let the string F remain upon the wheels D and G; take away also the bearer MX from the whirling-board d , and instead of it put on the machine A B (*Plate XXI. fig. 14. Astronomy*), fixing it to the centre of the board by the pins c and d , so that the end ef may rise above the board to an angle of 30 or 40 degrees. On the upper part of this machine, there are two glass tubes a and b , close stopped at both ends; each tube being about three-quarters full of water. In the tube a is a little quicksilver, which naturally falls down to the end a in the water; and in the tube b is a small cork, floating on the top of the water, and small enough to rise or fall in the tube. While the board b with this machine upon it continues at rest, the quicksilver lies at the bottom of the tube a , and the cork floats on the water near the top of the tube b . But, upon turning the winch and moving the machine, the contents of each tube will fly off towards the uppermost ends, which are farthest from the centre of motion: the heaviest with the greatest force. Consequently, the quicksilver in the tube a will fly off quite to the end f , occupying its bulk of space and excluding the water, which is lighter than itself: but the water in the tube b , flying off to its higher end e , will exclude the cork from that place, and cause it to descend toward the lowest end of the tube; for the heavier body, having the greater centrifugal force, will possess the upper part of the tube, and the lighter body will keep between the heavier and the lower part.

This experiment demonstrates the absurdity of the Cartesian doctrine of vortices: for, if the planet be more dense or heavy than its bulk of the vortex, it will fly off in it farther and farther from the sun; if less dense, it will come down to the lowest part of the vortex, at the sun: and the whole vortex itself, unless prevented by some obstacle, would fly quite off, together with the planets.

9. If a body be so placed upon the whirling-board of the machine (*fig. 13.*) that the centre of gravity of the body be directly over the centre of the board, and the board be moved ever so rapidly by the winch B, the body will turn round with the board, without moving from its middle; for, as all parts of the body are in equilibrio round its centre of gravity, and the centre of gravity is at rest in the centre of motion, the centrifugal force of all parts of the body will be equal at equal distances from its centre of motion, and therefore the body will remain in its place. But if the centre of gravity be placed ever so little out of the centre of motion, and the machine be turned swiftly round, the body will fly off towards that side of the board on which its centre of gravity lies. Then, if the wire C (*fig. 15.*) with its little ball B be taken away from the semi-globe A, and the flat side ef of the semi-globe be laid upon the whirling-board, so that their centres may coincide; if then the board be turned ever so quickly by the winch, the semi-globe will remain where it was placed: but if the wire C be screwed into the semi-globe at d , the whole becomes one body, whose centre of gravity is at or near d . Fix the pin c in the centre of the whirling-board, and let the deep groove b cut in the flat side of the semi-globe be put upon the pin, so that the pin may be in the centre of A (*see fig. 16.* where the

groove is represented at b), and let the board be turned by the winch, which will carry the little ball B (*fig. 15.*) with its wire C, and the semi-globe A, round the centre pin c ; and then, the centrifugal force of the little ball B, weighing one ounce, will be so great as to draw off the semi-globe A, weighing two pounds, until the end of the groove at e strikes against the pin c , and so prevents A from going any farther: otherwise, the centrifugal force of B would have been great enough to have carried A quite off the whirling-board. Hence we see, that if the sun were placed in the centre of the orbits of the planets, it could not possibly remain there; for the centrifugal forces of the planets would carry them quite off, and the sun with them; especially when several of them happened to be in one quarter of the heavens. For the sun and planets are as much connected by the mutual attraction subsisting between them, as the bodies A and B are by the wire C fixed into them both. And even if there were but one planet in the whole heavens to go round ever so large a sun in the centre of its orbit, its centrifugal force would soon carry off both itself and the sun: for the greatest body placed in any part of free space could be easily moved; because, if there were no other body to attract it, it would have no weight or gravity of itself, and consequently, though it could have no tendency of itself to remove from that part of space, yet it might be very easily moved by any other substance.

10. As the centrifugal force of the light body B will not allow the heavy body A to remain in the centre of motion, even though it be twenty-four times as heavy as B; let the ball A (*fig. 17.*) weighing six ounces be connected by the wire C with the ball B, weighing one ounce; and let the fork E be fixed into the centre of the whirling-board; then, hang the balls upon the fork by the wire C in such a manner, that they may exactly balance each other, which will be when the centre of gravity between them, in the wire at d , is supported by the fork. And this centre of gravity is as much nearer to the centre of the ball A than to the centre of B, as A is heavier than B; allowing for the weight of the wire on each side of the fork. Then, let the machine be moved, and the balls A and B will go round their common centre of gravity d , keeping their balance, because either will not allow the other to fly off with it. For, supposing the ball B to be only one ounce in weight, and the ball A to be six ounces; then, if the wire C were equally heavy on each side of the fork, the centre of gravity d would be six times as far from the centre of B, as from the centre of A, and consequently B will revolve with a velocity six times as great as A does; which will give B six times as much centrifugal force as any single ounce of A has: but then, as B is only one ounce, and A six ounces, the whole centrifugal force of A will exactly balance that of B; and therefore each body will detain the other, so as to make it keep in its circle.

Hence it appears, that the sun and planets must all move round the common centre of gravity of the whole system, in order to preserve that just balance which takes place among them.

11. Take away the forks and balls from the whirling-board, and place the trough A B (*fig. 18.*) thereon, fixing its centre to that of the board by the pin H. In this trough are two balls D and E of unequal weights, connected by a wire f , and made to slide easily upon the wire C stretched from end to end of the trough, and made fast by nut-screws on the outside of the ends. Place these balls on the wire C, so that their common centre of gravity g may be directly over the centre of the whirling-board. Then, turn the machine by the winch ever so swiftly, and the trough

trough and balls will go round their centre of gravity, so as neither of them will fly off; because, on account of the equilibrium, each ball detains the other with an equal force acting against it. But if the ball E be drawn a little more towards the end of the trough at A, it will remove the centre of gravity towards that end from the centre of motion; and then, upon turning the machine, the little ball E will fly off, and strike with a considerable force against the end A, and draw the great ball B into the middle of the trough. Or, if the great ball D be drawn towards the end B of the trough, so that the centre of gravity may be a little towards that end from the centre of motion, and the machine be turned by the winch, the great ball D will fly off, and strike violently against the end B of the trough, and will bring the little ball E into the middle of it. If the trough be not made very strong, the ball D will break through it.

12. Mr. Ferguson has explained the reason why the tides rise at the same time on opposite sides of the earth, and consequently in opposite directions, by the following new experiment on the whirling-table. For this purpose, let *abcd* (fig. 19.) represent the earth, with its side *c* turned toward the moon, which will then attract the water so as to raise them from *c* to *g*: and in order to shew that they will rise as high at the same time on the opposite side from *a* to *e*; let a plate A B (fig. 20.) be fixed upon one end of the flat bar D C, with such a circle drawn upon it as *abcd* (fig. 19.) to represent the round figure of the earth and sea; and an ellipse as *efgb* to represent the swelling of the tide at *e* and *g*, occasioned by the influence of the moon. Over this plate A B suspend the three ivory balls *e, f, g*, by the silk lines *b, i, k*, fastened to the tops of the crooked wires H, I, K, so that the ball at *e* may hang freely over the side of the circle *c*, which is farthest from the moon M at the other end of the bar; the ball at *f* over the centre, and the ball at *g* over the side of the circle *g*, which is nearest the moon. The ball *f* may represent the centre of the earth, the ball *g* water on the side next the moon, and the ball *e* water on the opposite side. On the back of the moon M is fixed a short bar N parallel to the horizon, and there are three holes in it above the little weights *p, q, r*. A silk thread *o* is tied to the line *k*, close above the ball *g*, and passing by one side of the moon M goes through a hole in the bar N, and has the weight *p* hung to it. Such another thread *n* is tied to the line *i*, close above the ball *f*, and passing through the centre of the moon M and middle of the bar N, has the weight *q* hung to it, which is lighter than the weight *p*. A third thread *m* is tied to the line *b*, close above the ball *e*, and passing by the other side of the moon M, through the bar N, has the weight *r* hung to it, which is lighter than the weight *q*. The use of these three unequal weights is to represent the moon's unequal attraction at different distances from her; so that if they are left at liberty, they will draw all the three balls towards the moon with different degrees of force, and cause them to appear as in fig. 21, in which case they are evidently farther from each other than if they hung freely by the perpendicular lines *b, i, k*. Hence it appears, that as the moon attracts the side of the earth which is nearest her with a greater degree of force than she does the centre of the earth, she will draw the water on that side more than the centre, and cause it to rise on that side; and as she draws the centre more than the opposite side, the centre will recede farther from the surface of the water on that opposite side, and leave it as high there as she raised it on the side next her. For, as the centre will be in the middle between the tops of the opposite elevations,

they must of course be equally high on both sides at the same time.

However, upon the supposition, the earth and moon would soon come together; and this would be the case, if they had not a motion round their common centre of gravity, to produce a degree of centrifugal force, sufficient to balance their mutual attraction. Such motion they have; for as the moon revolves in her orbit every month at the distance of 240,000 miles from the earth's centre, and of 234,000 miles from the centre of gravity of the earth and moon, the earth also goes round the same centre of gravity every month at the distance of 6000 miles from it, *i. e.* from it to the centre of the earth. But the diameter of the earth being, in round numbers, 8000 miles, its side next the moon is only 2000 miles from the common centre of gravity of the earth and moon, its centre 6000 miles from it; and its farthest side from the moon 10,000 miles. Consequently the centrifugal forces of these parts are as 2000, 6000, and 10,000; *i. e.* the centrifugal force of any side of the earth, when it is turned toward the moon, is five times as great as when it is turned toward the moon. And as the moon's attraction, expressed by the number 6000, at the earth's centre, keeps the earth from flying out of this monthly circle, it must be greater than the centrifugal force of the waters on the side next her; and consequently, her greater degree of attraction on that side is sufficient to raise them; but as her attraction on the opposite side is less than the centrifugal force of the water there, the excess of this force is sufficient to raise the water just as high on the opposite side.

To prove this experimentally, let the bar D C with its furniture be fixed on the whirling-board of the machine, (fig. 14.) by pushing the pin P into the centre of the board; which pin is the centre of gravity of the whole bar with its three balls *e, f, g*, and moon M. Now, if the whirling-board and bar be turned slowly round by the winch, till the ball *f* hangs over the centre of the circle, as in fig. 22, the ball *g* will be kept towards the moon by the heaviest weight *p* (fig. 20.), and the ball *e*, on account of its greater centrifugal force, and the less weight *r*, will fly off as far to the other side, as in fig. 22. And thus, whilst the machine is kept turning, the balls *e* and *g* will hang over the ends of the ellipse *lfk*. So that the centrifugal force of the ball *e* will exceed the moon's attraction just as much as her attraction exceeds the centrifugal force of the ball *g*, whilst her attraction just balances the centrifugal force of the ball *f*, and makes it keep in its circle. Hence it is evident, that the tides must rise to equal heights at the same time on opposite sides of the earth. See Ferguson's Lectures on Mechanics, lect. 2, and Desag. Ex. Phil. vol. i. lect. 5.

WHIRL-WIND, a wind that rises suddenly, and is exceedingly rapid and impetuous when risen, but is soon spent. In this case, the gusts of wind proceed from different quarters at the same time, and meet in a certain place, where the air acquires a circular, or rotatory, or screw-like motion, either ascending or descending, as it were, round an axis, which axis is sometimes stationary, and at other times moves on in a particular direction. This phenomenon, called a whirl-wind, gives a whirling motion to dust, sand, water, part of a cloud, and sometimes even to bodies of great weight and bulk; carrying them either upwards or downwards, and lastly, scattering them about in different directions.

There are divers sorts of whirl-winds, distinguished by their peculiar names: as, the *prester*, *typho*, *turbo*, *exhydria*, and *cenephias*.

The *prester* is a violent wind breaking forth with flashes of lightning. This is rarely observed; scarcely ever without the *ecnephas*. Seneca says, it is a *typho*, or *turbo*, kindled or ignited in the air.

The *ecnephas* is a sudden and impetuous wind, breaking out of some cloud; frequent in the Ethiopic sea, particularly about the Cape of Good Hope. The seamen call them *travados*.

The *exhydria* is a wind bursting out of a cloud, with a great quantity of water. This only seems to differ, in degree, from the *ecnephas*, which is frequently attended with showers.

A *typho*, or *vortex*, most properly called a *whirl-wind*, or *hurricane*, is an impetuous wind, turning rapidly every way, and sweeping all round the place. It frequently descends from on high. The Indians call it *orancan*; the Turks, &c. *oliphant*. It is frequent in the Eastern ocean, chiefly about Siam, China, &c. and renders the navigation of those parts exceedingly dangerous.

Dr. Franklin, in his Physical and Meteorological Observations, read to the Royal Society in 1756, supposes a whirl-wind and a water-spout to proceed from the same cause; their only difference being, that the latter passes over the water and the former over the land. This opinion is corroborated by the observations of M. de la Pryme, and many others, who have remarked the appearances and effects of both to be the same. They have both a progressive as well as a circular motion; they generally rise after calms and great heats, and occur most frequently in the warmer latitudes: the wind blows every way from a large surrounding space both to the water-spout and whirl-wind; and a water-spout has, by its progressive motion, passed from the sea to the land, and produced all the phenomena and effects of a whirl-wind: so that there is no reason to doubt their being meteors arising from the same general cause, and explicable upon the same principles, furnished by electrical experiments and discoveries. See HURRICANE, and WATER-SPOUT.

For Dr. Franklin's ingenious method of accounting for both these phenomena, see his Letters and Papers, &c. vol. i. p. 191, &c. p. 216, &c.

WHISKET, or WISKET, in *Rural Economy*, a term often used provincially to signify a basket, especially in the northern counties. See BASKET.

WHISKY, a term signifying *water*, and applied in the Highlands and islands of Scotland and in Ireland to strong water or distilled liquor. The spirit drank in the North is drawn from barley, and is said to be preferable to any English malt-brandy: it is strong, but not pungent, and free from the empyreumatic taste or smell.

WHISPERING. See HEARING, ATTENTION, &c.

WHISPERING-Places, such as *domes* and *galleries*, depend on this principle, that the voice being applied to one end of an arch, easily passes by repeated reflections to the other.

Thus, let A B C (*Plate XV. Pneumatics, fig. 8.*) represent the segment of a sphere; and suppose a low voice uttered at D, the vibrations extending themselves every way, some of them will impinge upon the points E, E, &c. and thence be reflected to the points F, F, &c. thence to G, G, &c. till at last they meet in C; where, by their union, they cause a much stronger sound than in any part of the segment whatever, even at D the point whence they first proceeded.

Accordingly, all the contrivance in a whispering-place is, that near the person who whispers there be a smooth wall, arched either cylindrically, or elliptically; in which case he

will be heard distinctly by another person, who places his ear pretty near the wall on the opposite side. A circular arch will do, but not so well. It is demonstrated by all the writers on CONICS (which see), that if from any point in the circumference of an ellipse two lines be drawn to the foci, those lines make equal angles with one curve at that point. Consequently, the sound which is produced in one focus of an elliptical chamber, and is reflected from the wall to the other focus, makes all the angles of incidence equal to the angles of reflection respectively. Hence that focus is the place where the sound is best heard.

Places famed for the conveyance of whispers are, the prison of Dionysius at Syracuse, which increased a soft whisper to a loud noise; the clap of one's hand to the sound of a cannon, &c.; the aqueducts of Claudius, which carried a voice sixteen miles; and divers others enumerated by Kircher in his *Pinururgia*.

The most considerable in England are, the dome of St. Paul's, London, where the ticking of a watch may be heard from side to side; and a very easy whisper be sent all round the dome: this Dr. Derham found to hold not only in the gallery below, but above upon the scaffold, where a whisper would be carried over one's head round the top of the arch, though there be a large opening in the middle of it into the upper part of the dome: and the famous whispering-place in Gloucester cathedral, which is no other than a gallery at the east end of the choir, leading from one side of it to the other. It consists of five angles and six sides, the middlemost of which is a naked window; yet two whisperers there hear each other at the distance of twenty-five yards. See Birch's *Hist. of the Royal Society*, vol. i. p. 120. See ECHO.

WHIST, or WHISK, a well-known game at cards. Mr. T. Matthews, one of the last and most approved writers on the game of whist, has published (1816) a tenth edition of his "Advice to the Young Whist Player, &c." in which he has comprised, under the detail of 108 maxims, such instructions as are necessary to be observed by those who wish to play this game with skill and success. It would far exceed our limits, if we attempted to follow him in this detail; and an abridgment, if it were practicable, would be of little use; nor indeed is it necessary, as those who are desirous of acquiring a knowledge of the minutiae of the game will consult the author, whose "Advice" may be easily and cheaply procured. We shall, however, select some of those instructions that are the most important, and subjoin those laws of the game that serve to prevent or settle disputes among players.

The following maxims comprehend those instructions that relate to leads, to which we have annexed some other directions that are immediately connected with them. It is highly necessary, says Mr. M., to be correct in leads. When a good player plays an eight, and then a seven, it may be known that he leads from a weak hand; and the contrary, when he plays the seven first: the case is the same with a tray or a deuce.

Good players never lead a nine or ten, but for one of these reasons:

- 1st. From a sequence up to the king.
- 2d. From nine, ten, knave, and king.
- 3d. When the best of a weak suit not exceeding three in number.

1. The safest leads are those that are furnished by sequences of three or more cards; in which case the player is advised to lead the highest, and to put on the lowest to his partner's lead, and to put the highest on his adversary's; and with a tierce to the king and several others, to begin with

with the knave. If he has no sequences, he is instructed to lead from his most numerous suit; if strong in trumps, to lead rather from one headed by a king than a queen; but with three or four small trumps, Mr. Matthews prefers leading from a single card to a long weak suit. But the players of the old school never lead from a single card without six trumps. In some cases, Mr. M. observes, this may be occasionally done with very great, though not certain, advantage; *e. g.* when A has four small trumps, ace, queen, &c. of the second suit; king, knave, &c. of a third; and a single card of the fourth. To lead from three cards, unless in sequences, is bad play, and only proper when you have reason to think it is your partner's suit, and then lead off the highest. Unless, says Mr. M., you have a strong suit yourself, or have reason to suppose that your partner has one, do not trump out unless you have six trumps. It is generally right to return your partner's lead in trumps, unless he leads a nine or ten, called an equivocal card, because it is led with propriety, both from strong and weak suits.

2. With ace, king, knave, and three small trumps, play the ace and king; with only two, the king, and wait for the finesse of the knave. In other suits, without great strength in trumps, or with the hopes of a particular point, do not wait for the finesse.

3. Ace, king, and five others, lead the ace in all suits. With four or less, the lowest, if trumps. In other suits always the ace, unless all the trumps remaining are with you and your partner; in this case, a small one.

Mr. M. advises not to lead trumps merely because an honour is turned up on your left, nor to be deterred from it if on your right-hand; either, he says, is proper, if the circumstances of your hand require trumps to be led; but neither otherwise.

It is equally advantageous to lead up to an ace as through an ace; not so much so to a king, and disadvantageous to the queen turned up.

When cards are nearly equal, says this author, the point to which all the manoeuvres of good whist players tend, is to establish a long suit, and to preserve the last trump, to bring it into play, and to frustrate the same play of their adversaries. With an honour (or even a ten), with three other trumps, by well managing them, you have a right to expect success. In this case, do not over-trump your right-hand adversary early in the hand; but throw away a losing card, by which, there remaining but twelve trumps, your own hand is strengthened, and your partner has the tenace, in any suit that is led; whereas, had you over-ruffed, you would have given up the whole game, to secure one trick. But there are reasons for breaking this rule:—1st. If your left-hand adversary has shewn a decided great hand in trumps, (in which case make your tricks while you can,) or 2d. If your partner decidedly means to force you,—to understand if this is the case, you are to observe, if your partner plays the winning or losing card of the suit you have refused. If the former, it is by no means clear he means to force you, and you play your own game. If the latter, you are to suppose him strong in trumps, and depend on this, to protect your long suit: a due reflection on this will convince you of the value of that maxim, which enjoins you never to play a strong game with a weak hand, or *vice versa*.

It is difficult to judge when to lead trumps. The following situations will assist the beginner to reason, and in general direct him properly:

1st. With six trumps, on supposition your partner has a strong suit.

2d. If strong in other suits, though weak in trumps yourself.

3d. If your adversaries are playing from weak suits.

4th. If your adversaries are at the point of eight, and you have no honour, or probability of making a trump by a ruff.

With king, queen, ten, &c. in all suits, lead the king; but if it passes, do not pursue the lead, as certain the ace is in your partner's hand, as it is often kept up, but change your lead, and wait for the return from your partner when you have the finesse of the ten, if necessary.

King, queen, and five others, in all suits, the king. With four or less in trumps, lead the lowest. In other suits, always the king, unless you have the two only remaining trumps, if so you may play a small one.

King, knave, ten, &c. in all suits, lead the ten. King, knave, and two or more small ones, the lowest.

You should not lead from king, knave, and a small one, unless it is clearly your partner's suit, in which cases play off your king and knave.

Queen, knave, nine, and others, lead the queen. Queen, knave, with one other, the queen. Queen, knave, with two more, the lowest. Queen, ten, and two others, the lowest. Queen, and three small ones, the lowest. Queen, or knave, with only two, the queen, or knave.

The trump card sometimes occasions a deviation from these rules. A has the ace or king, with sequence from the ten downwards, of the suit of which his left-hand adversary turns up knave, or queen—A should lead the ten. If the knave or queen be put on, you have a finesse on the return with the nine; if not, your partner, with an honour, will pass it, and it is either way advantageous.

That which is denominated under-play, is returning the lowest of your left-hand adversary's lead, though you have the highest in your hand, with a view of your partner's making the third best, if he has it, and still retaining the commanding card in your hand.

To explain this further, suppose A fourth player, has ace and king of his left-hand adversary's lead; to under-play, he wins the trick with the ace, and returns the small one, which will generally succeed, if the leader has not the second and third in his own hand. You will see by this, if you lead from a king, &c. and your right-hand adversary, after winning with a ten or knave, return it, you have no chance to make your king, but by putting it on.

The following is another situation to under-play; A remains with the first, third, and fourth cards of a suit, of which he has reason to suppose his left-hand adversary has the second guarded; by playing the fourth, it is often passed, and A makes every trick in the suit.

When it is at your option to be 8 or 9, it is material always to choose the former score. When at eight, with two honours, look at your adversary's score, and consider if there is a probability they should save their lurch, or win the game, notwithstanding your partner holds a third honour; if not you should not call, as it gives a decided advantage against you in playing for tricks.

Laws of Whist.—1. If a card is turned up in dealing, the adverse party on naming it may call a new deal, unless they have looked at or touched the cards, so as to have occasioned it; but if any card except the last is faced, it is undoubtedly a new deal.

2. Should any card-player have but twelve cards, and the others their proper number, the deal is good, and he who has the twelve cards pays for any renounce he may have

have made; but if either have fourteen cards, the deal is lost.

3. If the dealer does not turn up the last card, the deal is lost. But if the card is shewn, and falls on its face by accident afterwards, the deal in this case shall stand good.

4. The dealer should leave the last card on the table till he has played; after which nobody can ask for it, though they may inquire what is trumps at any time. Should he leave it on the table after the first round, it may be called, as if shewn by accident.

5. Every person has a right before he plays to call on the players to place their cards before them, which is, in other words, to ask who played them. It is therefore a quibble to say they have no right to make that demand.

6. The partner who reminds his partner to call after the trump is turned up, forfeits a point.

7. If one of the players omit playing to a trick, and remains with a card too many, it is at the option of the adversaries to call a new deal.

8. If A plays out of his turn to his partner's lead, the last player may play before the first: if to his adversary's, his partner may be compelled to, or prevented from winning the trick at their option.

9. Mistakes relative to tricks may be rectified at any time during the game, whether called or not. Also honours, if proved to have been called in time, though not scored; but they cannot be claimed after the trump is turned up.

10. If one party calls at any score but eight, the adversaries may, after consulting, call a new deal; the same, if one calls without two, or the other answers without one honour.

11. If any player calls after he has played, the adversaries may call a new deal; but not consult together.

12. Whoever calls, having only one honour in his hand, should forfeit in proportion to any advantage that actually does or may possibly accrue from the fault. If it should prevent the adversaries from calling, after the hand is played out, the honours shall take place of the tricks.

13. If any person plays out of his turn, the adversaries have the option to call that card at any time, or direct the player whose turn it was, to play any suit they choose.

14. If A, supposing that he has won a trick, leads again before his partner has played to it, the adversaries may oblige his partner to win it, if he can.

15. Any player may call a card from his adversary, if he names it, and proves the separation. Should he name a wrong one, he may have his best or worst card called of any suit played during the deal.

16. Cards thrown down cannot be taken up again; but may be called by the adversaries. They may be shewn down by the player, if sure of every trick.

17. There are in fact four penalties on a revoke, which take place of every other score. The adversaries may take three tricks from the party revoking, or three from their score, or add three to their own; and if there still should remain enough to make the party revoking game, they cannot win it, but remain at nine.

There is often judgment required in taking the penalties of a revoke. Before the score is advanced, if the party revoking has won nine tricks, the least consideration will shew, that the adversaries should take three of them, for if they add three to their own score, they still leave the odd trick to the

former; but if the revoking party be at eight, it is better for the adversary to score three points, as the odd trick leaves the former at nine, which is in every respect a worse point than eight. On other occasions, it is only to calculate how the different scores will remain after each mode of taking the penalty; and it will be obvious which will be the most advantageous—never losing sight of the points of the game; *i. e.* scoring eight or five yourself, or prevent your adversary from doing so.

18. A revoke is not established before the party revoking has played again, or the trick been turned and quitted; but the adversaries, at their option, may call from the highest or lowest of the suit at the time, or the card shewn at any time during the deal.

19. If a revoke is claimed, the adversaries forfeit the penalties of a revoke, if they mix the cards before it is determined.

20. No revoke can be claimed after the cards are cut for the next deal.

21. A case having occurred in which A played out of his turn, and B, his partner, was directed to play a trump; but B had another suit, and three or four cards were played before it was discovered that B had a trump in his hand: it was decided, that the cards should be taken up again, and a trump led by B as directed.

22. A case occurred in which A called at eight, but his partner did not answer, though he had an honour, because he had a bet on the odd trick. The adversaries contended that the deal should not stand; and reference being made to Mr. M., he decided that the game was fairly won, because there could be no possible advantage made of the circumstance as far as related to the game, though it might as to the trick, if that had been the case referred; and their case produced the following law: *viz.* No one is obliged to answer to his partner's call, even though he has the other two honours in his hand.

23. No player, having three honours in his hand, can be precluded from taking advantage of them at any time previous to his playing a card. This law was grounded on the following case; *viz.* A at the score of eight, on gradually opening his hand, saw two honours in it immediately, and told his partner of it, who did not answer: but A continuing to look over his cards found a third honour, and shewed them down. It was contended that he had no right to do this, as Mr. M. thought improperly, upon which he proposed the above-mentioned law. We here subjoin a maxim connected with this case.

When at eight, with two honours, look at your adversary's score, and consider if there is a probability they should save their lurch, or win the game, notwithstanding your partner holds a third honour; if not you should not call, as it gives a decided advantage against you in playing for tricks.

24. Whoever shall by word or gesture manifestly discover his approval or disapprobation of his partner's mode of play, or ask any questions but such as are specifically allowed by the existing laws of whist, the adversary shall either add a point to his own score, or deduct one from the party so transgressing, at his option.

25. It is now settled, that either of the players may insist on the cards being placed at any time previous to their being put together. It is also settled, that where a bet is made, that either of the parties scores two, the bet is won by honours, though the adversary has won the game by cards—supposing it betted that A makes two points, if B, his

his adversary, being at seven, makes three by cards, if A has two by honours, he still wins his bet.

The odds of this game are calculated according to the points, and with the deal, in the following manner :

- 1 love - - 10 to 9
- 2 love - - 10 to 8
- &c. &c.

Except that 9 is considered as something worse than 8. It is 3 to 1 in favour of the first game. The odd trick has been always supposed in favour of the leader ; but Mr. M. is of opinion, that this is an error, as the dealer has the advantage in this, as in every other score.

We shall here subjoin an explanation of two terms that are universally used, but not generally understood, viz. *tenace* and *finesse*.

“The principle of the *tenace* is simple. If A has the ace and queen of a suit, and B, his adversary, has the king and knave, the least consideration will shew that if A leads, B wins a trick, and *vice versa* of course ; in every situation it is the mutual plan of players by leading a losing card to put it into the adversary’s hand to oblige him to lead that suit, whereby you preserve the *tenace*. So far is easily comprehended ; but it requires attention with practice to apply the principle, so obvious in the superior, to the inferior cards, or see that the same *tenace* operates occasionally with the seven and five, as the ace and queen, and is productive of the same advantage. A, last player, remains with the ace and queen of a suit not played, the last trump, and a losing card ; B, his left-hand adversary, leads a forcing card. *Query*—How is A to play ? *Answer*—If three tricks win the game, or any particular point, he is not to ruff, but throw away his losing card, because his left-hand adversary being then obliged to lead to his suit, he remains *tenace*, and must make his ace and queen. But upon a supposition that making the four tricks gains him the rubber, he should then take the force, as in these situations you are justified in giving up the *tenace* for an equal chance of making any material point.

“The *finesse* has a near affinity to the *tenace*, except that the latter is equally the object where two, and the former only where there are four players. A has the ace and queen of a suit led by his partner, now the dullest beginner will see it proper to put on the queen ; and this is called *finessing* it, and the intention is obviously to prevent the king from making, if in the hand of his right-hand adversary. Should it not be there, it is evident you neither gain nor lose by making the *finesse* ; but few players carry this idea down to the inferior cards, or see that a trick might be made by a judicious *finesse*, against an eight, as a king ; but to know exactly when this should be done, requires more skill than in the more obvious cases, united with memory and observation. Another case of *finesse* even against two cards frequently occurs, and the reason on reflection is self-evident.

“A leads the ten of a suit, of which his partner has the ace, knave, and a small one ; B should *finesse* or let the ten pass, even though he knows the king or queen are in his left-hand adversary’s hand, because he preserves the *tenace* and probably makes two tricks ; whereas, had he put on his ace, he could make but one—in short, *tenace* is the game of position, and *finesse*, the art of placing yourself in the most advantageous one.” Matthews’s Advice, &c. ed. 10. 1816.

M. de Moivre has solved this problem : To find the odds that any two of the partners, that are pitched upon, have not the four honours ? M. de Moivre concludes from this solution,

1. That it is 27 to 2, nearly, that the dealers have not the four honours.
2. That it is 23 to 1, nearly, that the eldest have not the four honours.
3. That it is 8 to 1, nearly, that neither one side nor the other have the four honours.
4. That it is 13 to 7, nearly, that the two dealers do not reckon honours.
5. That it is 20 to 7, nearly, that the two eldest do not reckon honours.
6. That it is 25 to 16, nearly, that either one side or the other do reckon honours, or that the honours are not equally divided.

The same learned author also determines, that the odds for the partners who have eight of the game, if dealers, against those who have nine, is nearly as 17 to 11. But if those who have eight of the game are eldest, the odds will be nearly as 95 to 77. And that without considering whether those who have eight are dealers, or eldest, there is one time with another the odds of somewhat less than 7 to 5 ; and very nearly that of 25 to 18.

It is a question likewise belonging to this game, what the probability is that a player has a given number of trumps dealt him ; particularly, it has been often taken as an equal wager, that the dealer has at least four trumps. M. de Moivre has computed the following tables ; shewing for the dealer, as well as the other gamblers, what the probability is of taking precisely any assigned number of trumps in one deal. And thence by a continual addition of the numbers, or of such part of them as is necessary, it is easily found what the probability is of taking at least that number.

Chances of the Dealer to have besides the Card turned up.	Trumps.	Chances of any other Gambler to have precisely.
3910797436	0	8122425444
20112672528	I.	46929569232
41959196136	II.	110619698904
46621329040	III.	139863987120
30454255260	IV.	104897990340
12181702104	V.	48726808416
3014663652	VI.	14211985788
455999544	VII.	2583997416
Tab. I. 40714245	VIII.	284999715 Tab. II.
2010580	IX.	18095220
48906	X.	603174
468	XI.	8892
1	XII.	39
Sum = 158753389900		476260169700 = sum,
is the common denominator ; being the combinations of 12 cards in 51.		is the common denominator ; being the combinations of 13 in 51.

By the help of these tables several useful questions may be resolved ; as, 1. If it is asked, what is the probability that the dealer has precisely III trumps, besides the trump card ? The answer, by Table I., is $\frac{4662}{15875}$; and the probability of his having some other number of trumps is

$\frac{11213}{15875}$. But if the question had been, what is the probability that some other gamester, the eldest hand for instance, has precisely IV trumps? The answer, Table II., is $\frac{104898}{476260}$.

2. To find the chance of the dealer's not having fewer than IV trumps: add his chances to take 0, I, II, which are 39108, 201127, 419592; and their sum 659827 taken from the denominator 1587534, and the remainder made its numerator, the probability of the dealer having IV or more trumps will be $\frac{927707}{1587534} = \frac{329}{563}$, a little above

$\frac{7}{12}$. The wager, therefore, that the dealer has not IV trumps, is so far from equal, that whoever lays it throws away above $\frac{1}{5}$ of his stake.

But if the wager is, that the dealer has not V trumps; then 466213 (the chances of his having III besides the trump card) is to be added to the chances for 0, I, II; which will make the chance of him who lays this wager to be nearly $\frac{317}{455}$; and that of his adversary $\frac{138}{455}$.

And hence, if wagers are laid that the dealer has not IV trumps, and has not V trumps, alternately; the advantage of him who lays in this manner will be nearly $11\frac{1}{2}$ per cent. of his stakes.

3. To find the odds of laying that the eldest hand has at least III, and at least IV trumps, alternately; the numerator of the one expectation is (by Table II.) 3150119, and of the other 17514720, to the denominator 47626017;

whence the advantage of the bet will be $\frac{15}{514}$, or three per cent. nearly.

Again, if it is laid that the trumps in the dealer's hand shall be either I, II, III, or VI; the disadvantage of this bet will be only 15s. 4d. or about $\frac{3}{4}$ per cent.

In like manner, the odds of any proposed bet of this kind may be computed: and from the numbers in the tables, and their combinations, different bets may be found which shall approach to the ratio of equality; or if they differ from it, other bets may be assigned, which, repeated a certain number of times, shall balance that difference.

4. And if the bet includes any other condition besides the number of trumps, such as the quality of one or more of them; then proper regard is to be had to that restriction.

Let the wager be that the eldest has IV trumps dealt him; and that two of them shall be the ace and king. The probability of his having IV trumps precisely is, by

Table II., $\frac{104898}{476260}$: and the different fours in 12 cards

are $\frac{12}{1} \times \frac{11}{2} \times \frac{10}{3} \times \frac{9}{4}$. But because 2 out of the 12 trumps are specified, all the combinations of 4 in 12 that are favourable to the wager, are reduced to the different two that are found in the remaining 10 cards, which

are $\frac{10}{3} \times \frac{9}{2}$. And this number is to the former as 1 to 11: the probability, therefore, is reduced by this restriction to $\frac{1}{11}$, of what else it had been: that is, it is re-

duced from near $\frac{1}{5}$ to about $\frac{1}{52}$. De Moivre's Doctrine of Chances, p. 172, &c. ed. 3d.

WHISTLE, BOATSWAIN'S. See CALL.

WHISTLE-Fish, a name given by the people of Cornwall to a species of gadus, with only two fins on the back, otherwise called *mustela fluviatilis*. See GADUS, and MUSTELA.

WHISTON, WILLIAM, M.A. in *Biography*, an English divine and mathematician, was the son of the rector of Norton near Twycrofs, in Leicestershire, and born in the year 1667. He finished his education as a sizer at Clare-hall, Cambridge, applying with great diligence to the study of mathematics, and composing devout meditations corresponding to the early bent of his disposition. Having also received the degree of B.A. in 1690, and being elected fellow of his college, he took pupils; and in 1693 became M.A. and entered into holy orders. Soon afterwards he declined the office of tutor, and was appointed chaplain to Dr. More, bishop of Norwich. His acquaintance with sir Isaac Newton commenced in 1694, and produced a change in his philosophical system, from that of Des Cartes to that of Newton. On the principles of this philosophy, he published, in 1696, his "Theory of the Earth," which was refuted by Keill. Having been presented by his patron, the bishop, to the living of Lowestoft in Suffolk, he resigned his chaplainship, and in order fully to discharge his religious duties procured the assistance of a curate. Of his invincible and moral scrupulous integrity, he gave an early instance by refusing his vote to a person who solicited a fellowship of Clare-hall, and who had abandoned the bacchanalian party with which he was connected, and which he apprehended to be the most powerful, and promised future sobriety; and giving this reason for his refusal: "Sir, you have confessed that you sacrificed your integrity to your preferment, and thereby have made it impossible for me to serve you." Being obliged to vacate his fellowship by marriage, sir Isaac Newton nominated him his deputy as professor of mathematics, allowing him all the profits of the office; and in 1703 he surrendered to him the professorship itself. Upon this accession, he resigned his living, settled at Cambridge, and was appointed by Dr. More, bishop of Ely, catechetical lecturer of St. Clement's. Having already published "A Short View of the Chronology of the Old Testament, and the Harmony of the Four Evangelists," and "Tacquet's Euclid," he presented to the public in 1706 his "Essay on the Revelation of St. John;" and in the following year he preached the Boyle's lecture sermon on the subject of the "Accomplishment of Scripture Prophecies." In the year 1706 he began to entertain doubts concerning the divinity of Christ, and in the prosecution of his inquiries he was led to adopt Arian opinions, which were further confirmed by the perusal of the "Apostolical Constitutions," reckoned spurious by most writers, but pronounced by Whiston to be "the most sacred of the canonical books of the New Testament." In 1708 he offered an "Essay on the Apostolical Constitutions" to be printed at the University press, but it was rejected; however, in 1709, he published sermons and essays supporting these opinions. His invincible perseverance caused him to be deprived

deprived of the catechetical lecture, and at the same time he declined receiving the salary which the bishop wished to continue. His situation at the University became very precarious, and in October 1710 he was expelled from it, in conformity to a statute against maintaining doctrines contrary to the established religion. In the following year he also lost his professorship; and having no further employment at Cambridge, he removed to London, and published an account of the proceedings against him, and also books in defence of his sentiments, which he retained without regarding any worldly considerations. His purposes were fixed, and he declared to two friends, who wished him to pay some attention to his present welfare, "you may as well persuade the sun to come down from the firmament, as turn me from this my resolution." Hoadly and Clarke remonstrated; but all their pleas were unavailing. All his future prospects seemed now to depend on his knowledge of mathematics, and accordingly in 1710 he published his "Prælectiones Physicæ-Mathematicæ; five Philosophiæ Clarissimi Newtoni Mathematica illustrata." At this time Addison and Steele, and several other persons, exerted themselves in procuring a subscription to his astronomical lectures. But at the close of this year he published the "Historical Preface" to a proposed work on Primitive Christianity, which subjected him to the inquisitorial animadversion of the lower house of convocation. Escaping, however, the apprehended consequences of their interference, he persisted in his course, and in 1711 printed this work which he had announced, and which had occasioned an alarm, in 4 vols. 8vo. The convocation, not sufficiently informed with regard to the extent of their power in cases of heresy, addressed the queen in order to obtain the opinion of the judges, who disagreed upon the subject, and no further measures were pursued by this body. However, in 1713, Whiston was prosecuted in the spiritual court; and as he did not appear to its citation, he was declared contumacious. Difficulties occurring on the part of the lay-judges, the business was deferred, and the prosecution was terminated by an act of grace in 1715. Whiston was at this time a professed member of the established church, and attended its worship, till at length he was refused admission to the sacrament; and therefore he opened an assembly for worship at his own house, and used a liturgy of his own composing. He also established a weekly meeting for the promotion of primitive Christianity, which subsisted for two years. Whilst he was thus occasionally engaged, he devoted himself to mathematical and philosophical pursuits; and in concert with Mr. Ditton, who was his colleague in his lectures, published a project for discovering the longitude at sea. But as their speculations were of no use, it will be sufficient to observe, that he published at last a method of ascertaining the longitude by observations of the eclipses of Jupiter's satellites, with tables of such eclipses for four years from the year 1738.

His zeal in religious discussions and projects remained unabated; and, among other publications in 1716 and the two following years, appeared several pieces founded on the supposed genuineness and authority of the apostolical constitutions. In 1719 he published a letter addressed to Finch, earl of Nottingham, on the "Eternity of the Son of God and his Holy Spirit," which received an answer from his lordship, that induced the clergy and universities to return him public thanks, and which caused Whiston's exclusion from the Royal Society, when he was proposed as a candidate in 1720. Sir Isaac Newton, it is said, who was of a very timid temper, took measures for defeating his election. As he was of opinion

that the Jews would be speedily restored to their native land, he procured models of the tabernacle of Moses and the temple of Jerusalem, upon which he read public lectures. In 1741 he undertook a survey of the coasts of England, in order to fix the longitude of places, and a chart to this purpose was published in 1745. It was in the year 1747 that he discontinued his attendance on the service of the church of England, and joined a Baptist church, in which connection he continued. In 1749 he published two volumes of memoirs of his own life, to which a third was added in 1750. Having attained to the 85th year of his age, he died at London in 1752, and was interred at Lyndon, where his daughter was married, and where a handsome tomb was erected in honour of his memory. "Fancy," says one of his biographers, "predominating over judgment, a warm head and honest heart, enthusiastic fervour, and disregard to common forms and worldly consequences, were the leading features of his character." He never hesitated in giving his opinion to all persons on all subjects, freely and without discrimination. Being once asked, in the presence of Addison, Pope, Walpole, Craggs, and others, "whether a secretary of state could be an honest man consistently with the duties of his station?" He gave his opinion that it would be of advantage to such an officer to speak openly what he knew, and declare his intentions without disguise. Mr. Craggs replied, "It might answer for a fortnight, but no longer." "Did you never, Mr. Secretary," returned Whiston, "try it for a fortnight?" When queen Caroline, who honoured Whiston's integrity, and was fond of his conversation, desired him to acquaint her what was particularly found fault with by censurers on her conduct; he replied, that her habit of talking at chapel was mentioned with disapprobation. She promised amendment, and wished him to point out any other faults. "When your majesty," said he, "has amended this, I will tell you of the next." A catalogue is given of Whiston's writings, which are very numerous, at the close of his "Memoirs of Dr. Clarke." He has also given a valuable "English Translation of Josephus," with plans, notes, and illustrations, to which are prefixed eight dissertations. Biog. Brit. Memoirs of his Own Life.

WHITAKER, JOHN, B.D. a divine of the established church, was born at Manchester, about the year 1735, and educated at Oxford, where he became fellow of Corpus-Christi college, taking the degree of M.A. in 1759, and of B.D. in 1767. His first work, viz. "The History of Manchester," appeared in 1771, 4to., in which he takes occasion to give a view of the state of the kingdom in general. This work, abounding in literary research and ingenious conjecture, gave reputation to the writer, and was followed in the same year by "The Genuine History of the Britons asserted." However, it is said that Mr. Whitaker's imagination in the progress of his years misled his judgment, of which he gave evidence in the second volume of his "History of Manchester," printed in 1775, though he still maintained his character for deep and learned investigation. As a clergyman, he became morning-preacher of Berkeley chapel, London, in 1773, from which situation he was soon after removed; and he resented his removal with the natural warmth of his temper. Such was his orthodoxy, that he declined accepting a valuable living that was offered to him by an Unitarian patron. In 1778 he succeeded, as fellow of his college, to the rectory of Ruan-Lanyhorne in Cornwall, where his contest about tithes was the occasion of much uneasiness to him. When mutual conciliation took place between him and his parishioners, he published in 1783 a course of Sermons on Death, Judgment, Heaven,

and Hell, which were rendered peculiarly impressive by the fervid eloquence with which he treated the subject, naturally awful and interesting. In 1787 he published his "Mary Queen of Scots vindicated," 3 vols. 8vo., in which he surpassed former writers in the zeal with which he vindicated this unfortunate queen, and crminated her enemies, Elizabeth, Cecil, Morton, and Murray. He also presented to the public the fruit of his learned research in "The Course of Hannibal over the Alps ascertained," 2 vols. 8vo. 1794; and in 1795 he advanced the highest monarchical principles in his work, entitled "The real Origin of Government," and also his orthodoxy in his "Origin of Arianism," zealously defending his sentiments in both these respects by contributions to the English and Jacobin Reviews, and British Critic. At length a paralytic stroke warned him of his approaching end, and after a gradual decline he imperceptibly closed life at his rectory in October 1808, at the age of 73, leaving a widow and two daughters. Gen. Biog.

WHITBREAD, SAMUEL, an eminent brewer, claims a place in a work devoted to the record and promotion of the arts and sciences, on account of the talents which he displayed and the character which he maintained in his advancement from small beginnings, to the possession of a fortune, that set him on a level with some of the first nobility of the country. The family from which he sprung belonged to the class of yeomanry, in the county of Bedford, which possessed some small property, and associated with that description of moderate dissenters, who occasionally conformed to the Church of England. Born in the village of Cardington near Bedford, about the year 1720, and educated probably with a view to trade, for which his family designed him, he was bound apprentice at a suitable age, for the term of seven years, to an opulent brewer in London; and after the expiration of that period, he remained for some time unsettled, as he was cautious in commencing business on his own account. At length, however, actuated by the laudable ambition of tracing the footsteps of those who, in a similar department, had risen to opulence and rank, he determined to make trial for himself, how far industry and activity, aided by economy, would avail to his success. Having disposed of his own patrimony, which could not have been very considerable, and deriving assistance from persons of opulence, who were encouraged to repose confidence in him by his known disposition and habits, he laid the foundation of a superstructure of fortune and reputation, which has had few parallels in the history of commerce. Simple in his manners, he was accustomed to appear at the corn-market in Mark-lane with a white apron, as the emblem of his occupation; and liberal in his disposition, he contrived to secure the attachment and active services of those with whom he was connected in his domestic arrangements, and in the conduct of his business. He well knew that by making those whom he employed partakers of his bounty, he gave them a kind of interest in his prosperity; and therefore on settling the annual balance of his accounts, he distributed amongst them donations, corresponding to their respective ranks and services. Whilst he gave 500*l.* to a confidential clerk, he extended his bounty even to the horse-feeders, to each of whom he usually gave 5*l.*

Advancing with sure, but rapid progress, his brew-house in Chifwell-street became a spacious quadrangle, consisting of an ample dwelling-house, work-houses, stoves, cellars, and every other kind of convenience both for habitation and business; while the stock, the plant, the dray-horses that would have mounted a regiment of cavalry, the casks, &c. might in process of time be estimated at nearly half a mil-

lion of pounds sterling. To this immense property, we might add a floating capital amounting to from 80 to 100,000*l.* serving to supply the demand of malt, hops, oats, &c. as well as the payment of clerks and servants. Thus by the direction and superintendance of a single individual, with the co-operation of a number of coadjutors in various ranks of subordination, the brew-house in Chifwell-street became the first establishment of the kind, not only in London, but in Europe, depending for its subsistence and singular prosperity on the approved quality of the article which it furnished. To the founder and principal proprietor, it became a mine of wealth, and an immense source of supply for purchases of land and houses, donations and bequests, that have given distinguished celebrity to the name of Whitbread. It is needless to recount the various estates which he purchased in his native county; we shall content ourselves with mentioning merely the Torrington manors and estates, for which he paid the sum of 120,000*l.*, besides 5000*l.* as a present to alderman Skinner the auctioneer, when the negotiation respecting it was completed. Of his benefactions and bequests to various objects of public utility and of private charity, it will be sufficient to say, that they indicated the liberality of his disposition, and the amplitude of the means which he derived from his singular prosperity. Mr. Whitbread was twice married; by his first wife he had several children: but his second wife, who was daughter of the first earl, and sister of the first marquis Cornwallis, and to whom he was married August 12, 1769, died December 27, 1770. He was for some years one of the representatives of the town of Bedford, and afterwards returned for the borough of Steyning. For the abolition of the slave-trade, he was a steady and ardent advocate; and as such he generously undertook from his private purse to make good all injuries that might be suffered by those who attended to give their testimony for this purpose. With this expression of benevolence he closed a life, during the progress of which he had amassed landed and chattel property to an immense amount, without any of those penurious habits, which have been in many instances the means of accumulating large fortunes, and of enabling those to die rich who have lived meanly and miserably. His death happened June 11th, 1796.

In 1799 his son, the subject of the next article, erected a splendid monument to his father's memory, in the church of Cardington; which monument was the last, and has been thought by some persons to be the best work of the late J. Bacon, R.A. The principal figure represents a dying man, supported by religion, in the form of a female, who points to the glory of heaven as a reward for his good actions; while the figure of benevolence, in a reclining posture, is weeping at his feet.

WHITBREAD, SAMUEL, a distinguished senator, was the son of the preceding by his first wife, and born in the year 1758. Destined to the inheritance of a large fortune, and possessing talents which by due cultivation would qualify him for a conspicuous station in public life, his father spared no expence in his education. At a proper age he was sent to Eton, where he also enjoyed the benefit of private tuition, and where he commenced an intimate acquaintance with Mr. W. H. Lambton, afterwards M.P. for the city of Durham, and Mr. now earl Grey, with whose family he became connected by a double alliance. From Eton he removed to Christchurch college, Oxford, and from thence to St. John's college, Cambridge, where he finished his education, and was graduated B. A. Mr. Whitbread senior, sagacious in discerning the early dawning of his son's future celebrity, liberally offered him all the advantages which might
be

be derived from foreign travel, and selected for his tutor and companion the present archdeacon Coxe, well known by a variety of valuable publications. Having travelled together through France, Germany, and Switzerland, they afterwards separated with professions of mutual regard. Mr. Whitbread, soon after his return, formed, in 1788, a matrimonial connection with Miss Grey, the sister of his Eton associate, who afterwards, by the advancement of her father, general sir Charles Grey, to an earldom, became lady Elizabeth Whitbread: his sister also, in process of time, married the present sir George Grey, bart. then a captain in the navy. Having acquired every necessary qualification for occupying a seat in the great council of the nation, and interested by an ample fortune either in possession or in prospect, as well as by genuine sentiments of patriotism, in its deliberations and resolutions, Mr. Whitbread offered himself, on the dissolution of parliament in 1790, as a candidate for Bedford, a borough which had been represented by his father, who at the same time offered himself for the borough of Steyning. Both elections were contested; but both father and son finally obtained their respective seats. Mr. Whitbread, junior, commenced his political career in parliament with an animated speech against the unconstitutional doctrine of "confidence," assumed on the part of ministers, who claimed an entire reliance on their wisdom and integrity. The occasion of this claim was a proposed war against Russia, for which the minister (Mr. Pitt) urged the house of commons to vote money, without previous and satisfactory information of the necessity, and much less of the justice or policy of this war, the object of which was the restoration of Oczakow to the Turks. The measure was unpopular; and though the minister obtained a majority, when the question was debated, he thought it most prudent to give up his object, and a pacification ensued, which prevented much calamity to the nation. About this time the abolition of the slave-trade occupied the public attention, and this was a measure to which the member for Bedford had always avowed himself a steady and zealous friend. In parliament he supported it not only by his vote, but by a display of eloquence which commanded universal applause. As an active magistrate, he directed his particular attention to the occurrences that took place in consequence of the scarcity in the year 1795; and in devising means of relief, he proposed that as the magistrates were empowered to fix a *maximum* of wages, so far as respects the husbandman, a *minimum* should be also preserved by law, in order thus to establish a more accurate proportion between the price of labour and that of the means of subsistence. With this view he introduced into the house a bill, which was approved by Mr. Fox and many other members; but as it was opposed by Mr. Pitt, his efforts were unavailing. The minister was no less unsuccessful in his plan for amending the poor laws, and meliorating the condition of the peasantry and working class. His plan indeed was much more extensive and complicated than that of Mr. Whitbread, which was simply calculated to enable the labourer to maintain himself by his wages, without the degrading as well as dispiriting necessity of seeking parochial relief.

The subject of this article was an undisguised and uniform opposer of the French war in 1793, because he thought it to be unnecessary and unjust; and yet he was a zealous advocate for measures of self-defence against the secret machinations and open attacks of a powerful and vindictive enemy. Accordingly he condemned the negligence of ministers, on occasion of the French attempt at invasion in 1797, by means of a squadron which appeared off Bantry bay, and moved the house for a committee of inquiry into

their conduct. His motion was evaded by the previous question. In every stage of the contest with France, and under every varying form of its government, he was anxious for peace, and an advocate for treating with its rulers in order to terminate hostilities, and to put a stop to the waste of national treasure and the effusion of human blood. His opinion on the conduct of ministers in the prosecution of this war, and their reluctance to enter into treaty for terminating it, was explicitly avowed in an eloquent speech, which he delivered on occasion of a motion by Mr. Dundas (then secretary of state) for an address to the throne in 1800, for the purpose of approving the conduct of his majesty's government. Anxious, however, as he was for peace, because he disapproved the war from its commencement, and because he thought it essential to the true interest of the country, he was no less solicitous to maintain the honour of the nation in obtaining it. No man in this respect was a more noble-minded patriot than himself; and if he consented to make any sacrifice, it was because he thought it absolutely necessary to the permanent prosperity of his native country. Whilst he claimed and exercised the privilege of pronouncing his own opinion of public men and political measures, he was a zealous advocate for the liberty of others, and interposed with his most vigorous exertions for the rescue of those who suffered imprisonment at home or exile to Botany bay, for too freely and imprudently divulging their opinions. During the short interval of the administration of Mr. Addington, (the present lord Sidmouth,) who succeeded Mr. Pitt in the year 1801, and made peace with Buonaparte, several popular measures were adopted, in which Mr. Whitbread cordially concurred; and in the year 1805 he distinguished himself as the public accuser of Mr. Dundas (created lord Melville) for malversations that had occurred, whilst he had occupied the post of treasurer of the navy. His charges against this nobleman were founded on a report of the commissioners of public accounts, from which it appeared that, during the exercise of his office, this noble lord had violated the law, by conniving at mal-practices and participating in unwarrantable emoluments; and that he was responsible for deficiencies amounting to 697,500*l.* These charges also implicated Mess. Trotter, Wilton, and Spratt; and the former in particular, who was paymaster of the navy department under lord Melville, and had taken out large sums of money on his own private account. In the investigation of this business, it was discovered, that the sums officially deposited in the Bank had been withdrawn, lodged with private bankers, and applied to other purposes besides those that were properly naval. Mr. Whitbread founded on several facts which he stated, a variety of resolutions which impeached the fidelity and honour of his lordship. To his motion relative to this business, Mr. Pitt moved an amendment, which was negatived by a majority of one (217 to 216), in consequence of the vote of the speaker. In consequence of these proceedings, the viscount resigned his office at the Admiralty-Board, and his name was expunged from the list of privy-counsellors. Upon the sudden demise of the premier, and a coalition between lord Grenville and Mr. Fox, the two latter came into office; and Mr. Erskine, being raised to the peerage, and appointed lord high chancellor, was destined to preside at lord Melville's trial. This nobleman having made his defence within the bar of the house of commons was replied to by the member for Bedford; and an impeachment being agreed upon, proceedings commenced in Westminster-hall, April 29th, 1806. The result, after a short trial, was the acquittal of his lordship by a majority, from all the charges alleged against him. Notwithstanding the unexpected termination of this trial, neither the

friends nor the enemies of the supposed delinquent attached any blame to the public accuser; but he was allowed to have conducted the business assigned to him with a dignity and propriety suitable to its delicacy and importance. In the case of lord Melville, as well as in that of Mr. Pitt, he knew how to distinguish between the man and the minister; and to pay a just tribute to the talents and dispositions of the former, whilst he criminated and condemned the latter. Having differed with Mr. Pitt with regard to his political measures almost through the whole of his public life, he took the opportunity which the trial of lord Melville afforded him of paying a just tribute of respect to his abilities and virtues, when his premature death must have vindicated the eulogist from the slightest suspicion of insincerity and adulation.

Of the new administration, he was a steady supporter; but though he had at an early period enlisted himself under the banners of Mr. Fox, and the earl Grey, his school-associate and brother-in-law, who was one of its distinguished members: he was their friend as ministers, not from personal and selfish motives, but from a conviction of his judgment that their principles and views were most favourable to the liberty and welfare of the British empire. Indeed he was regarded by many as an impracticable man, because in all great questions he was influenced by principle more than by any private and party attachment. What were his sentiments of the coalition ministry, and what were the grounds of the support which he afforded them, he had an opportunity of stating in the most explicit manner. At this time sir Francis Burdett offered himself a candidate for the county of Middlesex, and transmitted a circular letter to Mr. W., who had voted for him twice before, soliciting his support. This letter contained reflections on the coalition ministry, which led the subject of this article to decline giving his vote for sir Francis, and also to express his sentiments of the coalescing parties, which had been severely censured. "I have supported the present administration," says Mr. W., "from a conviction that they were united upon principles of real public utility, and for the purpose of carrying into execution plans of great national improvement, both in our foreign and domestic circumstances; and I cannot abandon them, because in a situation more difficult than that in which any of their predecessors have ever stood, they have not been able to effect what I believe to have been nearest the hearts of them all—I mean a peace with France; seeing such a peace could not have been obtained on terms consistent with national honour, and because time has not sufficed to mature and execute the schemes of internal improvement, which they have manifested their determination to pursue," &c. Having stated some other opinions with regard to the union of parties, in which he seems to have disagreed with sir Francis, he concludes: "These radical differences render it impossible for me to assist you in becoming a member of parliament. Different opinions may be maintained consistently with mutual and entire personal respect; such as I unfeignedly profess towards you. The determination you have taken to avoid the expence of conveyance and decorations so conspicuous at your former elections, does you honour; and I wish such an example could be followed by all other candidates," &c. The publication of this correspondence threatened a very undesirable termination; but it was happily prevented by the interposition of friends.

During this period, Mr. Whitbread took an active part in public affairs, and distinguished himself on a variety of occasions, guarding on the one hand with vigilant jealousy against an undue exertion of the royal prerogative, and on the other against its infringement by the democratical part

of the constitution. In February 1807, he renewed his attention to the existing system of poor laws, as it was his wish and incessant endeavour to improve it, and in so doing to render the peasantry happier, better, and less dependent. It was also an object, which he conceived to be of essential importance, to controul the several branches of public expenditure, and thus to relieve the distresses of the country. Much depended, he well knew, on peace with France, and to this desideratum his views and efforts were constantly directed. But he was almost ready to despair of this desirable event, "from the awful moment that death closed the scene upon the enlightened statesman (Mr. Fox) who had first commenced the negotiation." When the Grenville administration was obliged to retire, and a new parliament was convoked by their successors, he published a spirited address to his constituents, in which he stated the measures which had been projected and wholly completed or commenced during the existence of the late ministry, and the part which he had taken in the deliberations of the preceding parliament, closing with these memorable words: "I court your inquiry, and if you are satisfied in the result of it, I hope for your votes in the present election. If you do me the honour again to return me, I shall indeed be proud of it, and I will again endeavour to do my duty." The next important object of his attention was the education of the poor, as intimately connected with their morals and religion; but unable to obtain a legislative sanction to his plan, he was under a necessity of recurring to individual exertions and private subscription. During the important debates that occurred in 1809, with regard to the orders in council, he concurred with those who condemned this measure, and contributed first to their suspension, and at length to their utter discontinuance. With regard to the situation of Spain, he was one of those who censured the conduct of the French government, and who wished the natives to be stimulated to new exertions in behalf of the independence of their native country. "In 1809," says one of his biographers, "he took an active part in the inquiry and examination into the conduct of the royal duke who presided over the army, and although he found much to blame on that occasion, yet, at a future season, he seized the first opportunity to afford his testimony in behalf of his royal highness, whose administration as commander-in-chief had contributed not a little to the happy and glorious termination of the late contest. That event did not prevent him, however, after the overthrow of Buonaparte's government, from blaming the conduct of the Congress, and exposing the ambitious views of some of the sovereigns, particularly in respect to Saxony. On the return of the emperor from his exile in the island of Elba, the member for Bedford strongly and emphatically censured the declaration of the allies, more especially that part of it which seemed to recommend the detestable principle of assassination. He also loudly insisted both on the impolicy and injustice of a new war, on the ground that the executive power of the enemy was vested in the hands of any one particular person. But above all things he protested against the forcible restoration of the Bourbons by a foreign force, and the assumed right of dictating a government to France. Yet he most cordially joined in a vote of national gratitude to the duke of Wellington, for the memorable victory at Waterloo, although he at the same time boldly avowed that events had not altered his sentiments in respect to the pretended justice of the original contest."

In the variety of his personal and domestic concerns, in his attendance on parliamentary duties, and in his efforts for establishing and promoting institutions of public utility, and more especially such as pertained to the instruction

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instruction of the poor, Mr. Whitbread was assiduous and indefatigable; and whilst he was overwhelmed by a multiplicity of occupations, he voluntarily undertook a more Herculean labour than any other, which was the arrangement of the perplexed concerns of Drury-lane theatre. With every moment of his time thus occupied, and his mental powers unremittingly exerted, it is no wonder that his health should decline, and that his mind itself, though naturally vigorous and ardent, should be impaired by excess and intenseness of application. The consequence that might have been apprehended unhappily occurred, and the world was prematurely deprived of the benefit of his valuable services. "His countenance changed; he became drowsy, lethargic, and irritable; and he even supposed himself to have fallen into contempt." These indications of corporeal and mental decay were alas! too soon succeeded by that fatal catastrophe, which occurred on Thursday, July 6, 1815. "An inquest having been summoned by Mr. Gell, the coroner, met at eight o'clock the same evening, at the house of the deceased, No. 35, Dover-street, Piccadilly, and having entered his study, beheld Mr. Whitbread lying on his back, his arms and legs extended, with a deep incision on his throat from ear to ear, a small part in the front of the throat excepted. A looking-glass was opposite to him; his apparel and the floor were covered with blood; and the fatal razor was found at some distance!"

The verdict of the jury was as follows:—"That the deceased Samuel Whitbread, esq. died by his own hand; but that he was in a deranged state of mind at the time the fatal act was committed." His principles and character have been justly delineated by one of his biographers, and we shall select such particulars as are consistent with our contracted limits. "In politics he was a whig; yet a whig of the old school; one who wished to balance the royal power, by means of a due influence of the popular branch: but at the same time firmly and steadfastly to uphold both. Accordingly, he was always a strenuous, constant, and uniform advocate for a reform of the house of commons: but this great measure was grounded on the ancient and acknowledged bases; not on the visionary plans of annual parliaments and universal suffrage! As a patriot, he wished for the happiness and prosperity of his country; but these, he deemed most likely to be acquired, and most permanently enjoyed by cultivating the arts of peace; advancing the commerce; cherishing the manufactures; and encouraging the agriculture of his native land. Wars might indeed be popular, successful, glorious; but it was also incumbent and imperative that they should be both just and necessary. It was his firm opinion, that economy was to the full as proper for a state as for a private family: he was always, therefore, a decided friend of order, regularity, and good management. He hated jobs; he viewed placemen, courtiers, and contractors, with a jealous eye; and he disliked both unnecessary and excessive pensions, not only on account of the sums thus perverted from the public revenue; but also from their obvious tendency to produce meanness, sycophancy, and dependance.

"Mr. Whitbread was a strenuous advocate for national education, or instruction on a great scale. But finding himself unable to obtain a national sanction to this measure, he contented himself with his assistance and support as a private individual.

"He was an encourager of the fine arts; and always desirous that they should enjoy protection and applause."—"To agriculture, as a science calculated to advance the best interests of the nation, he paid particular attention."—"Horticulture also engaged his notice, and the gardens, and lawns,

and groves of Southwell, might have all been exhibited as fo many perfect specimens of care, neatness, and propriety.

"Although always doubtful of the justice of the late war, he never hesitated for a single moment as to the propriety of arming and defending his native country against the menaces and attacks of her enemies. He himself raised and commanded a body of sturdy yeomanry; and while he thus excited a martial ardour in his neighbourhood, he forgot not to enforce his favourite plan of fitting men, by means of education, for their respective situations in life. On this occasion, he instituted a school for the benefit of the non-commissioned officers; and contributed by all the means in his power to render it effectual.

"An only son, born and matured with the expectations of great opulence; it is but little surprising if he occasionally displayed a certain degree of haughtiness in his demeanour. Indeed it cannot be denied, that at times he appeared somewhat haughty and overbearing; but on the other hand, he must be allowed to have been admirably fitted for command; and was seldom known to exceed the bounds of moderation, but when he combated the injustice of power, assailed the infulence of office, or endeavoured to expose successful guilt to shame and to punishment.

"His heart constantly glowed with all the social affections. He was zealous in his friendships; while his enmities were transient and short-lived. His ear was ever ready to listen to the tale of the oppressed; his purse always open to succour those who had been reduced to distress by unexpected calamities. At length, after having lived and acted during the stormy politics of the French revolutionary contest, he was suddenly cut off, at a period when his services might have proved highly advantageous to his country; when the deceitful calm of peace seemed pregnant with greater and more formidable dangers than those arising out of a long, widespread, expensive, and destructive warfare!

"On the 11th July, 1815, when the marquis of Tavistock, on moving for a new writ for the borough of Bedford, decanted on the character, worth, and talents of the late member, his encomium was listened to amidst the loud cheerings of both sides of the house of commons:

"'Accustomed to defend his opinions with warmth and earnestness,' said he, 'the energies of his ample and comprehensive mind, would never permit the least approach to tameness or indifference. But no particle of animosity ever found a place in his breast, and he never carried his political enmities beyond the threshold of this house. It was his uniform practice to do justice to the motives of his political opponents; and I am happy to feel, that the same justice is done to his motives by them. To those who were more immediately acquainted with his exalted character; who knew the directness of his mind, his zeal for truth, his unshaken love of his country, the ardour and boldness of a disposition incapable of dismay, his unaffected humanity, and his other various and excellent qualities, his loss is irreparable. But most of all, will it be felt by the indigent in his neighbourhood. Truly might he be called the poor man's friend. Only those who, like myself, have had the opportunity of observing his conduct nearly can be aware of his unabated zeal, in promoting the happiness of all around him. His eloquent appeals to the house in favour of the unfortunate, will adorn the pages of the future historian; while at the present moment, they afford a subject of melancholy retrospect to those who have formerly dwelt with delight on the benevolence of a heart that always beat, and on the vigour of an intellect which was always employed for the benefit of his fellow-creatures!'"

He

He left behind him by lady Elizabeth, his mourning widow, two sons and two daughters.

The following memorandum of Mr. Whitbread's sudden death was written immediately after the lamentable event was ascertained, in the title-page of a very ancient edition of Cicero's "Paradoxa," by a friend who highly respected the stern virtues both of his public and his private character:—

SAMUEL WHITBREAD, armiger;

Vir illustis iste, quem omnes liberales brevi in tempore appellabunt

ANGLICUM CATONEM,

E terra fuit ereptus die sexto Julii, anno Christi 1815.

Ann. Biog. and Obit. for 1817.

WHITBURN, in *Geography*, a township of England, in the county of Durham; 4 miles N. of Sunderland.

WHITBY, DANIEL, a learned divine of the church of England, was born at Ruffden, in Northamptonshire, in 1638, and admitted to Trinity college, Oxford, in 1653, where he took the degree of M.A. in 1660, and became fellow of his college in 1664, in which year he first appeared as a writer against popery. In 1668 he was appointed chaplain to Dr. Seth Ward, bishop of Salisbury, and collated to a prebend in his church. In 1672 he took the degree of D.D., and about this time was made rector of St. Edmund's parish in Salisbury. From this time he became a considerable writer in the popish controversy, publishing "A Discourse concerning the Idolatry of the Church of Rome," 1674; "The Absurdity and Idolatry of Host-Worship proved," 1679; "The Fallibility of the Roman Church demonstrated," 1687; and "A Treatise of Traditions," in two parts, 1689. He also expressed, in common with several other liberal persons at this period, his wishes for an union of all Protestants, in a piece published in 1683, and intitled "The Protestant Reconciler; humbly pleading for Condescension to Dissenting Brethren in Things indifferent and unnecessary, for the Sake of Peace, &c." This publication was too liberal for the times, and called forth a host of adversaries. But the most formidable attack was that of the famous Oxford decree, which passed a censure on the following propositions contained in it; *viz.* "It is not lawful for superiors to impose any thing in the worship of God that is not antecedently necessary;"—"The duty of not offending a weak brother is inconsistent with all human authority of making laws concerning indifferent things;" which propositions were denominated in the decree false, impious and seditious doctrines; and the book was burnt in the quadrangle of the university schools. But it was still more humiliating to the author to be required by his patron, the bishop, to declare his sorrow for having written the work, and to renounce by name the two preceding propositions. This conduct was very unworthy of a Christian bishop, and fixes a permanent stigma on the memory of Ward. It reminds us of the Inquisition and Galileo. (See GALILEO.) Dr. Whitby, actuated probably by a desire to conciliate his adversaries, or urged to adopt this measure, published in the same year a second part of the book, in which he strongly presses the dissenting laity to join in full communion with the established church, and replies to all the objections of the Non-conformists against the lawfulness of their complying with its rites and ceremonies.

No man could more sincerely rejoice in the Revolution than Whitby, nor more cordially welcome the emancipation

of British subjects from all kinds of tyranny. Accordingly he published two tracts in favour of the oath of allegiance required on the accession of king William; and in one of these tracts he maintains the principle in the English government of an original contract between the prince and the people.

His capital work, however, was the result of fifteen years' study, and is intitled "A Paraphrase and Commentary on the New Testament," 2 vols. fol. printed in 1703, several times reprinted, and held in high estimation by biblical students. To the edition of 1710 he annexed a Latin appendix, containing an examination of Dr. Mill's various readings, under an apprehension that they might prove injurious to the authority of Scripture. This great work of Dr. Whitby was followed by several tracts on theological subjects, in which he seems to value himself on that freedom of discussion which, with new times, he was allowed to indulge, more especially as he occasionally strays beyond the fixed boundaries of what has been called orthodoxy. Among these tracts were, "The Necessity and Usefulness of the Christian Revelation;" "A Discourse concerning the true Import of the Words Election and Reprobation;" "The Extent of Christ's Redemption;" "The Grace of God;" "The Liberty of the Will;" "The Perseverance or Defectibility of the Saints;" "Four Discourses on Election and Reprobation;" "A Treatise on Original Sin," in Latin, in which he denies that the imputation of Adam's sin to his posterity has any fair ground in Scripture. Upon the publication of Dr. Clarke's "Scripture Doctrine of the Trinity," Dr. Whitby adopted his opinion, and wrote a Latin treatise, intended to prove that the controversies respecting the Trinity could not with certainty be determined from fathers, councils, or Catholic tradition. In connection with this subject of controversy, he published "A Dissuasive from Inquiry into the Doctrine of the Trinity; or, the Difficulties and Discouragements which attend the Study of that Doctrine." In the Bangorian controversy, he was one of the auxiliaries of Dr. Hoadly, and printed several tracts. He also published several sermons. But his last work, which did not appear till after his death, was "The last Thoughts of Dr. Whitby, containing his Corrections of several Passages in his Commentary on the New Testament; to which are added Five Discourses; published by his express Order." In the preface to this work, written at the close of a long life of learned and laborious inquiry, the author says, "when he wrote his Commentaries, he went on too hastily in the common beaten road of other reputed orthodox divines; conceiving first, that the Father, Son, and Holy Ghost, in one complex notion, were one and the same God, by virtue of the same individual essence communicated from the Father; which confused notion (he adds) he is now fully convinced to be a thing impossible, and full of gross absurdities." A short illness closed the life of this eminent biblical scholar, on March 24, 1725-6, at the age of 88. He is represented by a biographer as a man of great simplicity of character, singularly ignorant of worldly affairs, entirely devoted to his studies, but affable, pious, and charitable. He preserved a tenacious memory to the last, but through a defect of sight was obliged to employ an amanuensis. Biog. Brit.

WHITBY, in *Geography*, is a considerable sea-port town of the North-Riding of Yorkshire, England, situated between Flamborough-head and the entrance of the river Tees. Considering the ruins of the ancient abbey as the principal object of the town, the latitude of Whitby is 54° 29' 24" N., and the longitude 0° 35' 59" W. from the meridian of Greenwich. It is 47 miles N.E. of York, and

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246 miles from London. The town is placed at the mouth of the small river Esk, which divides it into two unequal parts. The direction of the river, running nearly due north towards the sea, determines that of the town, which extends along its banks. These banks rise almost suddenly from the river on both sides; particularly on the east, so as to leave but a very narrow stretch of level ground at the bottom, of which, indeed, a great part has, at different times, been gained from the bed of the river. This narrow space is literally covered with houses; but the town ascends the steep banks on both sides, and thus presents a romantic appearance, especially when viewed from the sea; the whole surmounted by the old weather-beaten church, on the verge of the eastern cliff, and the venerable remains of the abbey behind. The eastern half of the town extends about three-quarters of a mile; but the breadth where greatest does not exceed 150 yards. The western division is the largest, the most compact, and the most elegant. Although now of importance, Whitby was but inconsiderable in trade and population, until towards the beginning of the last century. Its origin may, however, be carried back to the foundation of the celebrated monastery in the seventh century. That the Romans, or the original Britons, had any establishment at Whitby, we have no grounds to affirm; although the opening of the river into the sea must have afforded a convenient station for fishing and navigation; of which, had the Romans been a commercial people, they would doubtless have availed themselves, especially on a tract of coast so little furnished with harbours adapted to their shipping. On this part of the coast may, perhaps, be placed the bay mentioned by Ptolemy, under the romanized name *Dunum Sinus*, of which the most commodious inlet was the mouth of the river, now, by a peculiar appropriation of a generic British name for water, called the Esk. After the establishment of the monastery of St. Hilda in the seventh century, the vicinity began to be inhabited. Under her successor Ælfleda, daughter of Oswy, the port had some share of shipping; for, in 684, the abbess took a voyage, with some monks of the abbey, to the isle of Coquet, on the coast of modern Northumberland, to have an interview with St. Cuthbert. Suffering and again restored with the abbey, after the devastation by the Danes in 867, Whitby obtained its present name, signifying the White town. It was also from the monastery occasionally called Presteby, or Priesttown. Although unnoticed in *Domesday-book*, Whitby, prior to 1189, had become of such importance, that the abbot erected it into a borough, with the customary privileges. Those privileges were soon after confirmed by a royal charter; and had no unfair means been employed to set them aside, Whitby might now have been a royal borough. But the liberties of Whitby were of short duration: the monks repented of their liberality to the town, and Peter, the succeeding abbot, in 1200, procured from king John a repeal of the charter of his predecessor. About the year 1538, Whitby is described by Leland as a "great fisher town;" and nothing more is added by Camden, who mentions the place fifty years later. For many years after the dissolution of the abbey, the vessels of the port were few and small; and the trade was inconsiderable until the establishment of the alum-works at Guisborough, at the close of Elizabeth's reign. A spirit of emulation being excited by the success of those works, a similar establishment was formed in 1615 at Sand's-end, within three miles of the town. The vicinity of Whitby abounding with the alum-mineral, other undertakings of the same kind were begun. Hence two important branches of industry were formed in the town; the one to supply the

alum-works with coal, the other to export the alum to distant parts. From these beginnings, the trade of Whitby increased; the schemes of the inhabitants were enlarged; the number of shipping was augmented; and new ships were constructed, for which timber was drawn from the oak-woods of the vicinity. In this manner, the trade and navigation of the town grew up to such a height, that, in the beginning of the present century, Whitby was the seventh in rank for tonnage among the ports of England. In 1816, the number of vessels belonging to the town was 280, carrying 46,341 tons, and navigated by 2674 seamen. Besides the carrying of coal, with the alum trade, and a share of foreign commerce, the number of vessels fitted out from Whitby for the Greenland whale-fishery, begun in 1753, was, in 1800, next to that of those sailing from London. As early as the middle of the 16th century, small wooden piers were constructed at the mouth of the Esk, for the protection of the fishing-craft: but in 1632 stone piers were begun, through the exertions of sir Hugh Cholmley, who, by the favour of the earl of Strafford, his relation, obtained a general contribution over England in aid of the work, when nearly 500*l.* were collected. The navigation of Whitby becoming of importance, acts of parliament were obtained, in 1702 and 1723, for constructing a pier, which now extends above two hundred yards from the cliff on the east side of the harbour, westward to the channel of the Esk. By this work, security was obtained for the town as well as the shipping, both of which were greatly exposed to north-easterly winds. Another pier, on the west side, was afterwards added, running out about an equal distance towards the sea. By subsequent additions and improvements, the harbour has been essentially benefited. The west pier, now carried out to the length of three hundred and forty yards, is constructed with large blocks of squared stone, and terminates in a circular head, with embrasures for a battery. Within the piers, vessels to the number of five hundred may lie, but all on the ground at low water. The harbour is divided into the outer and the inner by a drawbridge, so constructed as to allow ships of two hundred tons to pass through. In the latter, which is capacious and secure, on both sides of the river are constructed several dry docks, and other accommodations for ship-building. The vessels built for the coal-trade are particularly valued for their strength and durability. One built in 1724 was lost on the Lincolnshire coast in 1810, but did not go to pieces: another, wrecked a few years ago, was above one hundred years old. In neap-tides the water rises from ten to twelve feet at the entrance of the harbour; but in ordinary spring-tides the depth extends from fifteen to eighteen feet. In the equinoctial gales, the depth of water is sometimes increased to twenty-three or twenty-four feet. The trade of the port of Whitby is but small in proportion to its shipping, as many of the largest vessels are employed in time of war as transports, and at other times by the merchants of London, and of other ports. The trade of the town is, however, considerable for its situation, in a country abounding with moors, where few manufactures are carried on. The alum-works in the environs are of great antiquity, and may not improbably be carried back to the Roman times. But the first work established in Britain, in later times, was begun by sir Thomas Chaloner in 1595, on his estate at Belman-rock, near Guisborough, twenty miles to the westward of Whitby. Since that period, alum-mineral has been extracted in various other places, particularly at Sand's-end, three miles west from Whitby, where the work is still in a prosperous state. Until the year 1789, the alkaline lees

employed in the manufacture were prepared from kelp, or sea-weed, burnt on the shore: but since that period kelp has been gradually superdisplaced by black-ashes, made from the refuse of soap-boilers' lees. The average annual quantity of alum manufactured in the Whitby district, for the last twelve years, was 2840 tons; but in 1816 the quantity was 3155 tons. Little alum is now exported, nearly the whole being sent to London. The number of persons, including artificers and boys, belonging to the works, is about 600. (See ALUM.) Thin seams of coal have, for upwards of seventy years, been wrought in the environs of Whitby, but of a very inferior quality, and used only in the interior parts of the country.

Whitby contains no public building of note. The town-hall, erected by the late Mr. Cholmley, is a heavy pile of the Tuscan order. The poor-house, extensive, and judiciously managed, affords a comfortable refuge for the distressed, and tends to diminish the heavy burthen of the parish-rates. A dispensary, liberally supported, for distributing advice and medicines to the poor, was established in 1780. The parish-church stands near the top of a hill, on the east side of the town, a little to the northward of the ruins of the abbey, accessible from the bottom by an inconvenient ascent of 190 stone steps. The architecture of the edifice was originally what is absurdly styled Gothic; but it has gone through so many alterations, that little of its ancient appearance now remains. The church-yard is excessively crowded with grave-stones; but the sea-air of Whitby is so destructive of stones, that inscriptions are soon effaced. For the use of the numerous inhabitants, a spacious chapel of ease has been erected in the lower part of the town; and for the country part of the parish, which is of great extent, three others have been built. That at Sleights, four miles from the town, is a handsome edifice. Roman Catholics, Quakers, and various other classes of dissenters, have their respective places of worship in the town. According to the parliamentary returns of 1811, the houses of this town were 1395, and the inhabitants 6969: but in the spring of 1816, the population was found, by a careful inquiry, to have increased to 10,203. The inhabitants of the country part of the parish were then estimated at 1477 persons.

The town of Whitby is close, irregular, and unpleasant; but the environs are romantic and beautiful. These are embellished with the country-residences of the opulent inhabitants, mostly erected on commanding situations: the most interesting object of all, however, is the celebrated Abbey, of great antiquity, having been originally founded in the year 655. Before the sanguinary but decisive battle of Leeds, on the banks of the Oire, in which he utterly overthrew and slew his invading foe, Penda, king of the Mercians, Oswy, king of the Northumbrians, vowed, if successful, to erect and endow a monastery, and to consecrate to the service of religion in it his daughter Ælfleda, then scarcely a year old. In discharge of this engagement, he founded the monastery of Streonshalh, of the Benedictine order; with this peculiarity, that it was to contain both monks and nuns, all under the government of St. Hilda, the first abbess. It is, nevertheless, probable, that the introduction of the monks, by which the institution became in all respects similar to that of the celebrated abbey of Fontevraud, in the west of France, did not take place till several years after its establishment. The monastery was begun in 657, and dedicated to St. Peter; but such was the veneration entertained for St. Hilda, that it was always called by her name, and to her was the foundation usually ascribed. While Hilda was abbess, the synod of

Whitby was held in 664, in which, notwithstanding her opposition, strengthened by that of Colman, the festival of Easter was directed to be celebrated at the time adopted by the sovereign pontiff, instead of that which had been in general observance in Britain. Dying in 680, Hilda's place as abbess was filled by Oswy's daughter, Ælfleda. Till the year 867, the abbey continued to prosper; but it was then overthrown by the sons of Lodbrog the Dane. In this state it remained until after the Norman Conquest: the lands in the neighbourhood were granted to Hugh, the first earl of Chester, from whom they passed to William de Percy, ancestor of the Percys of Northumberland. By him the monastery was restored from its ruins under a prior; but in the reign of Henry I. it was again raised to the rank of an abbey. Although pillaged by a Norwegian fleet in the time of abbot Richard, who died in 1175, its revenues at the dissolution, under Henry VIII., amounted to 505*l.* 9*s.* 1*d.* At this epoch, the site and lands, partly by grant and partly by purchase, became the property of sir Richard Cholmley, a descendant of the family of Cholmondeley, in Cheshire.

Of Whitby-abbey, the ruins of the church alone remain; but by these, which are still considerable and conspicuously picturesque, it appears to have been a magnificent structure. The exterior length of the church, which is built in the usual form of a cross, is 310 feet; the breadth at the west end, including the buttresses, is 84 feet; the length of the cross 153 feet. The church probably occupies the site of the Saxon building erected before the Conquest; but of it, nor even of the edifice constructed immediately after the revival of the monastery, no vestige now remains. The present structure is of different ages, and exhibits different styles of architecture. The eastern part, or choir, evidently the oldest, was probably built by Richard de Burgh, who was abbot from 1148 to 1175, and who rebuilt the chapter-house. The lower part of the tower, and most of the pillars, which are all clustered, were perhaps erected at the same time; but the north transept and the upper part of the tower are of a later date. The ornaments of the windows in those parts, the beautiful range of niches on the walls within, the tracery of the circular window in the north end, &c. seem to indicate the work of the close of the 13th or the beginning of the 14th century. The west front is the latest part of the whole, probably of the time of Edward III., or in the end of the 14th century.

The alum-rocks in the vicinity of Whitby are not less curious than valuable, from the variety of petrified substances they contain. Besides the usual petrifications of shells and other marine bodies, parts of the human skeleton have been occasionally discovered. In the early part of the last century, Dr. Woodward, the celebrated naturalist, dug up on the scar, or cliff, on the east side of the harbour, the petrified arm and hand of a man, having all the bones and joints very visible. About 1743 was found, in the alum-rock, the complete skeleton of a man; but it was broken to pieces by taking from the bed. A similar discovery is said to have been made about nine years ago; but the skeleton was broken without any scientific person having examined it. In 1758, the bones of a crocodile, as they were imagined to be, were drawn from the rock, and transmitted to the Royal Society, by whom an account of them was published in the 50th volume of the Philosophical Transactions. About four years afterwards, the skeleton of a horse was found in the alum-works at Salt-wick, thirty yards under the surface. Ammonites, or cornua-ammonis, vulgarly called snake-stones, abound, with other testaceous petrifications, in the aluminous schistus in the vicinity of Whitby;

Whitby; on which account, probably, the town has chosen three ammonites for its arms.

Robin-Hood's Bay, six miles south-east from Whitby, is a noted fishing-station, frequented for protection by many a vessel passing along that extended tract of inhospitable shore. Among the country-seats in the vicinity of Whitby, which are not numerous, is Mulgrave castle, the mansion of the earl of Mulgrave, situated five miles westward from the town, on a lofty eminence, commanding a most extensive prospect both by land and sea. Near to the southward stand the remains of the ancient baronial castle of Mulgrave. Manifest evidences of Roman occupation are to be seen in various parts of the surrounding country. The Roman road from *Eboracum* (York), northwards by the vicinity of New Malton, (perhaps the *Derwentio* of Antonine,) and apparently terminating at Durnsley, near the sea, three miles W. from Whitby, is in many places very perceptible. Along its course still remain traces of Roman encampments, of which the camps at Cawthorn, 19 miles S.W. from Whitby, supposed to be the *Delgovitia* of Antonine, are very perfect. These works are noticed in general Roy's "Military Antiquities of the Romans in Britain;" but much more particularly in "The History of Whitby and Streonshalh-abbey, with a Statistical Survey of the Vicinity," by the Rev. George Young, in 2 vols. 8vo. Whitby, 1817.

WHITCHURCH, a populous market-town in the north part of the hundred of North Bradford, and county of Salop, England, at the northern extremity of the county, is situated 20 miles N. by E. from Shrewsbury, and 160 miles N.W. by N. from London. The church, the chief object of notice, seated on the top of the hill over the town, is a spacious modern structure, erected in 1722, with a square tower 108 feet in height. Two recumbent stone figures are preserved from the ruins of the old church; of which one represents the celebrated John Talbot, the first earl of Shrewsbury, and marshal of the realm of France in the reign of Henry VI.: he was called the English Achilles, and was greatly renowned in the wars of France. Shakspeare, in his play of Henry VI., describes Talbot as a most formidable and magnificent character: "the terror of the French:—the scare-crow that affrights their children:—whose grizzly countenance made others fly:—none durst come near him for fear of sudden death." Another effigy represents Christopher Talbot, fourth son of John Talbot, second earl of Shrewsbury, and who was rector of Whitchurch and archdeacon of Chester. The rectory of this parish is one of the richest in the county. The castle has long been in ruins. Whitchurch has a very respectable free-school, in which many persons of eminence have been educated. Here are also meeting-houses for Protestant dissenters, a charity-school for children of both sexes, and six alms-houses for aged women, endowed by Mr. Samuel Higginson. A weekly market is held on Friday; and here are two annual fairs. The town is a place of much public resort during the horse-races which are occasionally held here. Among the natives of Whitchurch, was distinguished the celebrated linguist Abraham Whelock, who translated the New Testament into Persian, and assisted Dr. Brian Walton in the compilation of his polyglot Bible. Whelock published also an edition of the writings of the venerable Bede. He died in 1654. The population return of the year 1811 states the town of Whitchurch to contain 552 houses, and 2589 inhabitants: but the parish comprehends, besides the town, thirteen townships. The whole population is returned as 5332; the number of houses as 1107.

About nine miles to the northward of Whitchurch is Hawkstone-park, long the residence of the ancient family of the Hills, and a place celebrated for its natural and artificial beauties and curiosities. The mansion, an elegant modern building situated on the north side of a romantic hill, is adorned with a lofty portico of the Composite order. With the beauty of the exterior of the edifice, the interior fully corresponds: the chapel and the saloon are particularly elegant, and the latter is ornamented with valuable paintings. The grounds around the mansion are particularly interesting for their assemblage of naturally romantic scenes, to which art has greatly contributed. The grotto, the view from the cliff, called Paoli's-point, the retreat, or hermitage, St. Francis's cave, the Swiss bridge, the terrace, the obelisk, and the widely-extended prospect it presents over the surrounding country, the tower, the artificial river, the cottage, or whim, are among the many attractive features of Hawkstone-park, which owes much of its embellishment to the taste and munificence of the late sir Richard Hill, bart. The beautiful and romantic scenery of this noble place is fully detailed in T. Rodenhurst's "Description of Hawkstone."—Beauties of England and Wales, vol. xiii. Shropshire; by R. Rylance, 1811.

WHITCHURCH, a small but ancient borough and market-town in the upper half hundred of Evingar, Kingsclere division of Hampshire, England, is situated on the borders of Chute Forest, at the distance of 13 miles N. from Winchester, 24 miles N. by E. from Southampton, and 57 miles W.S.W. from London. It possesses the rights of a borough by prescription; and has sent two members to parliament since the twenty-seventh year of queen Elizabeth. The borough is the joint property of lord Sidney and lord Middleton; the freeholds, which give the right of voting, being conveyed by them to their respective friends for the purpose of performing the ceremony of an election. The freeholders are nominally about seventy, but the real electors are said to be appointed and influenced by the noblemen before-mentioned. The government of the town is vested in a mayor, annually chosen at the court-leet of the dean and chapter of Winchester, to whom the manor belongs. The town, though small, is remarkable for a variety of religious sects; there being, besides the church, places of worship for the Independents, Anabaptists, Quakers, Methodists, and Sandimianians. A market is held weekly on Friday, and three fairs annually. The population of the parish, as ascertained by the return of the year 1811, was 1407; the number of houses 281: the labouring classes are chiefly employed in woollen manufactures, and in agriculture.

Adjoining to the western end of Whitchurch is one of the entrances to the earl of Portsmouth's distinguished residence, Hurstbourne-park. Of late years the park has been much enlarged. The grounds contain considerable diversity of surface and scenery; and the conversion of a small stream into a broad piece of water, has tended very much to improve the place. In the old part of the park, trees have attained a size much beyond what might be expected from the chalk and flint which constitute so great a portion of the soil of North Hampshire. An old mansion-house stood in the bottom near the present parish-church and village: but the late lord Portsmouth pulled it down and erected the present building in a much more eligible and healthy situation. It stands on elevated ground, commanding extended and varied prospects, particularly to the south and the north. This mansion, erected by Mr. Meadows from the designs of James Wyatt, esq. consists of a centre and two correspondent wings connected to it by colonnades. The eastern wing contains the library and a chapel, and in

the western are apartments for servants. In the library were preserved a considerable body of the MSS. on various matters, philosophical and theological, of the illustrious Newton. They came into the possession of this family in consequence of the marriage of John, viscount Lymington, (son of the first earl of Portsmouth,) in 1740, with Catharine Conduit, great niece and coheirefs of sir Isaac. Those papers were examined by the late learned bishop (then doctor) Horsley, while preparing his edition of Newton's works. See NEWTON, *Sir Isaac*.

A little to the eastward of Whitchurch, near the London road, is Freefolk, noted for the paper-mills belonging to John Portal Bridges, esq. where the paper for the notes of the bank of England has been manufactured ever since the reign of George I. At Laverstock is the seat of William Portal, esq.; and in the adjoining parish of Overton is a handsome new house, the seat of — Jarvis, esq. In the village a silk-mill has been established. In various spots at no great distance from Whitchurch, are still visible evidences of Roman occupation. The great fofs-way, a Roman road leading from Sorbiodunum, or Old Sarum, to Vindonum, or Silchester, passes across the downs two miles to the northward of the town. Near the course of this way, at Egbury, a Roman encampment, forming an irregular quadrangle, may be easily traced, the rampart in most parts is still lofty; the longest side measures about 300 yards. On several eminences within the extent of a few miles from Whitchurch are circular or ring-polls, commonly called beacons; but evidently military stations of the ancient inhabitants of the country, to which they could resort, and on which they could secure their families and property, in the event of hostile assault from domestic or foreign foes.—*Beauties of England and Wales*, vol. vi. Hampshire; by J. Britton, F.S.A. and E. W. Brayley.

WHITE, GILBERT, M.A. in *Biography*, an agreeable writer of natural history, was born at Selborne in Hampshire in 1720, and completed his education at Oriel college, Oxford, of which he was elected fellow in 1744. In 1746 he took the degree of M.A., and in 1752 became one of the senior professors of the University. Unambitious in his temper, and fond of rural scenery, he fixed his residence in his native village, and devoted his time to literary pursuits, and particularly to the investigation of those subjects of natural history, which furnished him with lessons of piety and benevolence. The result of his observations was communicated to the public in his "Natural History and Antiquities of Selborne," 1789, 4to.; the first and principal part of which consisted of letters addressed to Mr. Pennant, and affords a variety of remarks, chiefly in the zoological departments, peculiarly amusing and no less instructive: and the second part treats of the antiquities of the place. Highly esteemed by all who knew him, he died in 1793; but after his decease, the natural history of his work was published separately in 2 vols. 8vo. 1802, with the addition of miscellaneous observations, and a Naturalist's Calendar, extracted from his papers, and of parallel remarks communicated by W. Markwick, esq., an accurate observer of nature in the county of Sussex. Gen. Biog.

WHITE, JOSEPH, Regius professor of Hebrew, and Laudian professor of Arabic, in the university of Oxford, was born in Gloucestershire in 1746, and being of humble origin, but devoted to reading whilst he was pursuing his father's occupation as a weaver, attracted the notice of a neighbouring gentleman, who sent him to Wadham college, Oxford. Having graduated M.A. in 1773, and chosen fellow of his college, he directed the main bent of his studies to the oriental languages, under the advice of Dr. Moor, after-

wards archbishop of Canterbury. Such was his proficiency in this department of literature, that in 1775 he was elected Laudian professor of Arabic, on which occasion he delivered and printed an oration on the utility of that language in theological studies. By the recommendation of bishop Lowth, he was appointed editor of the Philoxenian Syriac version of the four gospels, which he published in 1778. About this time he was nominated one of the king's preachers at Whitehall; and in a sermon preached before the university of Oxford, he recommended a revival of the English translation of the Old Testament. In 1780 he published a "Specimen of the Civil and Military Institutes of Timour," translated from a Persian version of the Mogul original, written by the conqueror himself. He also added a specimen of Persian poetry, and recommended the study of this language. These Institutes having been translated entire by major Davy, were published from the Clarendon press in 1783, under the inspection of professor White, who annexed a preface, indexes, and geographical notes.

As Bampton lecturer, to which office he was appointed in 1781, he preached a course of sermons before the university, which were printed in 1784, and much admired for their learning and eloquence. The general design of these sermons was to evince the excellence of the Christian religion, on a comparison with that of Mahomet. (See AL-CORAN.) It was discovered, however, somewhat to the disgrace of the professor, that he had derived very considerable assistance in the composition of these sermons from the masterly pen of Mr. Badcock, who had been a dissenting minister at South Molton, and afterwards conformed to the church, and that several of them were actually written by him. It was also known, that Dr. Parr, from his ample store of Greek literature, had furnished the materials that had been wrought up into two of these sermons. These facts were investigated and ascertained; and the charge against the professor was sufficiently substantiated, and it was founded, not so much on his want of ability for such productions, as on his indolence, and on certain habits unfavourable to study. His reputation, however, as a defender of Christianity was acknowledged, and he was presented to a prebend of Gloucester, and soon after was graduated D.D. About the year 1790 he married, and accepted a college-living in Suffolk. In this situation he prosecuted his studies, and having set up a press in his house, and furnished himself with oriental types, he and his wife performed the business of compositors, and a man and maid-servant that of the press. Hence originated his "Ægyptiaca," relating to the antiquities of Egypt; and an edition, with a version, of an account of that country by an Arabian writer named Abdollatif. In 1799 Dr. White published from the Clarendon press his "Diatessaron," or the harmony of the four evangelists, in Greek, a work useful to biblical students. He died in 1814, at the age of 68. Gen. Biog.

WHITE, one of the colours of natural bodies.

White is not so properly said to be any one colour, as a composition of all the colours; it being demonstrated by sir Isaac Newton, that those bodies only appear white, which reflect all the kinds of coloured rays alike, and that the light of the sun is only white, because it consists of all colours.

From the multitude of rings of colours, which appear upon compressing two prisms, or object-glasses of telescopes together, it is manifest, that these do so interfere and mingle with one another at last, as, after eight or nine reflections, to dilute one another wholly, and constitute an even and uniform whiteness: whence, as well as from other experiments,

it appears that whiteness is certainly a mixture of all colours; and that the light which conveys it to the eye is a mixture of rays endued with all those colours.

The same author shews, that whiteness, if it be most strong and luminous, is to be reckoned of the first order of colours; but if less, as a mixture of the colours of several orders: of the former sort, he reckons white metals; and of the latter, the whiteness of froth, paper, linen, and most other white substances. And as the white of the first order is the strongest that can be made by plates of transparent substances, so it ought to be stronger in the denser substances of metals, than in the rarer ones of air, water, and glass.

Gold or copper mixed either by fusion or amalgamation with a very little mercury, with silver, tin, or regulus of antimony, become white; which shews, both that the particles of white metals have much more surface, and therefore are smaller than those of gold or copper; and also, that they are so opaque, as not to suffer the particles of gold or copper to shine through them. And as that author doubts not, but that the colours of gold and copper are of the second or third order, therefore the particles of white metals cannot be much bigger than is requisite to make them reflect the white of the first order. See COLOUR, and *Colours from METALS*.

Hevelius affirms it as a thing most certain, that, in the northern countries, animals, as hares, foxes, bears, &c. become white in the winter time; and in summer resume their natural colours.

Black bodies are found to take heat sooner than white ones; by reason the former absorb or imbibe rays of all kinds and colours, and the latter reflect all.

Thus, black paper is sooner put into a flame, by a burning glass, than white; and hence black cloths, hung up by the dyers in the sun, dry sooner than white ones. See BLACK.

WHITE of the Eye, denotes the first tunic or coat of the eye, called *albuginea* and *conjunctiva*, because it serves to bind together or inclose the rest. See ADNATA, and EYE.

WHITE Ale, in *Rural Economy*, a liquor of the malt kind, which is said to be prepared somewhat in the following manner. Twenty gallons of malt are mashed with the same quantity of boiling water; when after standing the usual time, the wort is drawn off, and six eggs, four pounds of flour, a quarter of a pound of salt, and a quart of *grout*, are well beaten up together, and mixed with the above quantity of wort, which, after standing twelve hours, is put into a cask, and is ready for use the day afterwards.

It is observed by the writer of the Devonshire Corrected Report on Agriculture, who has supplied the above account, that this liquor is almost exclusively confined to the neighbourhood of Kingsbridge, in that county; and that it is a beverage which possesses a very intoxicating quality, and which is much admired by those who drink not merely to quench thirst. A mystery, it is said, hangs over the ingredient called *grout*, and the secret is said to be confined to one family in the above district only. No difficulty, however, it is supposed, could arise in ascertaining its component parts, by submitting a certain portion of it to the test of chemical examination. It is plain, it is said, that this liquor is of considerable antiquity, from the *terrier* of the advowson of Dodbrook, which expressly calls for the tithe of white ale.

This mild pleasant liquor may easily be made in other places.

WHITE Antimony Ore, in *Mineralogy*, *Antimoine Oxydée*,

Haüy, generally occurs diffused and crystallized in veins along with other ores of antimony on primitive rocks. See ANTIMONY.

WHITE Arsenic, and *Asbes*. See the substantives.

WHITE Bait, in *Ichthyology*. See CLUPEA.

WHITE Beam. See CRATÆGUS.

WHITE Bear. See POLAR Bear.

WHITE Brant, the *Anas Hyperborea*. See DUCK.

WHITE Bug, in *Gardening*, an insect of the bug kind, which is often very troublesome and hurtful in vineries, peach-houses, and other such sorts of houses for fruit-trees.

It is observed in the first volume of the "Memoirs of the Caledonian Horticultural Society," that the cause of this insect so frequently making its appearance in these houses, is much owing to the neglect in not washing the trees properly every day with the engine in many cases. That when a vinery is much overrun with it, in order to its removal, all the old bark should be stripped from off the vines, and all the shoots and trellis be properly sponged over with black soap and warm water. The writer always makes it a rule, at the time of the winter-pruning, to take off the outer bark, whether infested with them or not, as these bugs lodge between the old and new bark. That in regard to peach-trees, which are infested in this way with the white bug, they should be sponged all over in the same manner in the winter season; and if any bugs should appear in the spring, it is a good way, it is said, to tie pieces of mat round the stems and large branches of the trees; as about these parts these insects take shelter from the heat of the sun. Once every day these portions of mat should be taken off, and thrown away out of the houses. That soon after forcing is begun, the female of these bugs will be observed to be much larger than the male, at which time she constantly goes into some hollow of the trees or bark, and deposits her ova or eggs mostly in some thousands. These are easily capable of being discovered, and may be picked out of such hollows or crevices by means of a large pin, or small piece of sharpened stick; which is an effectual way of getting quit of them, and of preventing their future increase. See WASHING Fruit-Trees.

WHITE Campion, in *Agriculture*, a pernicious perennial weed in corn lands, pastures, and hedges, which is often difficult to destroy, except by good summer tillage of the ground. See WEED, and WEEDING.

WHITE Caterpillar, or Borer, in *Gardening*, a very destructive sort of insect of this kind, but which is not so numerous as those of the other kinds, nor does it attack and destroy the same parts of gooseberry-bushes, though equally injurious on others. It is of comparatively a small size too, in relation to those of the other sorts, the black and green, that infest these bushes; the former of which, the large or black, may be observed, it is said in a paper in the Horticultural Transactions of Scotland, lying during the winter months in large clusters on the under parts, and in the crevices of the bushes of these sorts; and that even in the month of February they have been found in that state. But that in the course of eight or ten days after that, if the weather be favourable, they will creep up the bushes in the day-time, feed on the young buds, and return to their nest during the night. That whenever leaves appear upon the bushes, they feed upon them until they arrive at maturity, which is generally about the month of June; after which they creep down upon the under sides of the branches, where they lodge until the crust or shell is formed over them. That in July they become moths, and lay their ova or eggs on the under sides of the leaves and of the bark. That the produce

produce of these ova or eggs, which come into life during the month of September, feed on the leaves so long as they continue green, and afterwards collect and gather together in clusters on the under sides of the branches, and in the cracks and openings of the bark, where they abide all the winter, as has been already seen. Consequently that winter is the most proper time for attacking and destroying this sort of these insects with success, as their destruction is then most effectually and completely accomplished by merely the simple operation of sprinkling and pouring a quantity of boiling hot water over and upon them, from a watering-pan or pot, by which no injury, it is said, will thereby be done to the bushes or gooseberry fruit-shrubs.

That the latter or green sort are in the shelly state in February, when they lie about an inch under the ground. That in the following month they come out small flies, and immediately lay their ova or eggs on the veins and under sides of the leaves. That these ova or eggs produce young caterpillars in the month of May, which feed on the leaves of the bushes until June or the succeeding month, when they cast off a blackish kind of skin, and afterwards crawl down from the bushes into the earth, where a sort of crust or shell grows over them, and in that state they continue until the following April.

The only method which this writer has hitherto found effectual in destroying this sort of these gooseberry-caterpillars, is first to dig the ground all around the bushes very deep during the winter season, by which means the greater part of them are either destroyed, or buried too deep ever to rise to the surface: or, secondly, in the month of April, when the flies make their appearance, to pick off all the leaves on which any ova or eggs are to be discovered, which is a tedious operation, but may be performed by children. If any of the insects should escape both these operations, they will, it is said, be discernible as soon as they come into life, by their eating holes through the leaves, and may then be easily destroyed, without the least injury to the bushes or fruit.

That this white kind bores the berry, and causes it to drop off from the bush. That they preserve themselves during the winter season in the chrysalis state, about an inch under ground, and become flies nearly at the same time with the latter of the above kinds. That they lay their ova or eggs on the blossoms, and that these eggs produce young caterpillars in May, which feed on the berries until they are full grown, and then creep down into the earth, where they remain for the winter in the shell state.

This sort of these caterpillars, too, may be best destroyed in the winter season, by having the land well and deeply dug all about the gooseberry-bushes at that time of the year, and by preventing them from climbing up the stems of the plants in the early spring season, for the purpose of laying their eggs, by every possible means that can be devised and resorted to by the gardener.

These are the best and most effectual methods that have yet been discovered by this writer, for the destruction of this and the two other sorts of gooseberry-caterpillars. For though many other modes of doing it have been tried, none have been found so certain and complete as these; and they have this advantage and consideration to recommend them, that they injure neither the bush nor the fruit. That the same thing cannot be said either of tobacco-liquor, snuff, or soap-suds, all which render the fruit constantly bitter and ill-tasted; and which, whatever may be the effect that they may have upon the smaller kind of caterpillars, it is certain, the writer thinks, that they have none upon the larger kinds, and that foot, lime, and lime-water, do not affect any sort

of caterpillar whatever, as the writer has sufficiently proved by repeated experiments with such substances.

WHITE Centaury, in *Agriculture*, an annual weed in woods and other such places; of which animals in general are not fond. It is said to form the basis of the famous Portland powder for the gout. See *WEED*.

WHITE Cinnamon. See *CINNAMON*.

WHITE Clover, in *Agriculture*, a well-known plant of the clover kind, which is perennial, and consequently lasts a number of years in the soil or land. It is said to require a deep free soil to bring it to any degree of luxuriant growth. Consequently but little of the land in many districts suits it; but it is sometimes sown with the common clover in about half the quantity. In the Berkshire Report on Agriculture, it is stated, that it is frequently confounded with the Dutch clover, that it affects a light soil, that it is much improved by rolling, and that it yields a very sweet hay when mixed with red clover, rye-grass, and nonsuch. That sheep are not very fond of it; and this is, probably, one reason why it is less cultivated than it deserves to be. It appears, it is said, to be the Irish shamrock; and that the powdered flowers of this clover being made into bread, were eaten by the natives of the sister island before the introduction of potatoes. It may be noticed, too, that it is capable of bearing flooding, which the red clover is not, and this is a very great advantage in its favour.

It is remarked also, that the real Dutch clover is not unfrequently sown with other grasses, in a larger or smaller proportion, as the farmer may think proper. That in some places of the above county it is the common practice to sow of broad clover eight pounds, yellow trefoil, or hop clover, four pounds, and of Dutch or white clover, two pounds, to the acre. If it be sown alone, about eight or nine pounds will be sufficient. It is getting into high estimation in the neighbourhood of Bray, in the above district, and in other places, and is sometimes called honey-suckle grass, from the sweetness of its smell. That to all sorts of cattle it forms an agreeable pasture, and especially to sheep, which thrive on it prodigiously. Even swine will fatten on this grass, the seed of which was imported from Flanders for some time after it began to be cultivated in this country, though it appears to be an indigenous plant. It has the excellent property of never wearing out by being close fed. See *TRIFOLIUM Repens*, and *HYBRIDUM*. Also *CLOVER*.

White clover is laid, in the Gloucestershire Agricultural Report, to be injurious to cow-stock, by *hoving* them when in abundance after rain in pastures.

WHITE Colours, in *Painting*, comprehend the following; *viz.* *FLAKE-White*, *White-LEAD* or *CERUSSE*, calcined or burnt *Harts-HORN*, the perfection of which depends upon its whiteness and firmness, distinguishable both by sight and touch, *PEARL-White*, *TROY-White*, and *EGG-Shell White*. (See the several articles.) The most delicate and perfect white in use, in its application to the purposes of painting in water-colours, is the artificial sulphate of barytes. According to Mr. Parkes (*Ess.* vol. ii.), it was first recommended and brought forward by Mr. Hume, of Long-Acre, who has long supplied the public with it under the name of "Permanent White." The same ingenious practical chemist says, that he knows of nothing so well calculated as this for marking bottles in a chemical laboratory, where the gases soon destroy the ink of common labels, and render them illegible. It is equally useful for marking jars, bottles, or boxes, which must be kept in a damp cellar, for it is not only imperishable in such situations, but preserves its extreme whiteness, and consequently the distinctness of the characters. We learn also from sir Humphrey

Davy's "Elements of Chemical Philosophy," that the combination of barytes and carbonic acid, made artificially by pouring a solution of carbonate of ammonia into a solution of nitrate of barytes, forms also a pigment of a very white colour.

WHITE Colours, in Dyeing. See COLOUR.

WHITE Copper Ore, in Mineralogy, is one of the rarest ores of copper, and has frequently been confounded with copper pyrites, and other ores of that metal. (See COPPER Ores.) Its colour is between silver-white and bronze-yellow; it occurs massive and disseminated; it has a metallic lustre. The fracture is fine-grained and uneven; it yields easily to the knife. The specific gravity of this ore is 4.5. It contains about 40 per cent. of copper mixed with iron, arsenic, and sulphur.

WHITE Copperas, Cordage, Eagle, and Egg-Shell. See the substantives.

WHITE Coss-Lettuce for Hogs, in Agriculture, the use of it in feeding these animals. A trial of it in this way is stated to have been made in Sussex, which is particularly deserving of attention: the weaning of young pigs, without much milk and some corn, is often a difficult business; but if this sort of lettuce will do it, which seems to be the case, no farmer should ever be without a rood, or half an acre of this sort of crop for this use.

In this trial, four ounces of this sort of lettuce-seed were sown very thick over two perches of ground in the beginning of March. A crop of potatoes was in rows at three feet distance; between which a double row of these lettuces was planted in May; both crops being afterwards kept clean by hand-hoeing. In the June following, they were begun to be used for three sows with little pigs, which were kept on these lettuces for six weeks; but these sows had wash in addition: the pigs were then weaned a fortnight earlier than usual; and after the weaning, the great use of the lettuces was found, for the pigs did admirably well upon them, until they all were gone in the middle of August. They were then fed as usual, with cabbage, turnip-tops, and other such vegetable matters, but fell off at once for want of the lettuces. See LACTUCA, and LETTUCE.

WHITE Crops, a term applied to all sorts of grain-crops, as wheat, rye, barley, oats, and some others, in contradistinction to those of the green and culmiferous kinds, such as cabbages, turnips, rape, tares, beans, and some others of a similar nature.

WHITE Darnel, a very troublesome and prolific weed among corn-crops, especially of the wheat kind. See WEED, &c.

WHITE Enamel. See ENAMEL, and ENAMELLING.

WHITE Face, or Blaze, in the Manege, a white mark upon a horse, descending from the forehead almost to the nose. It is called in French *chanfrin blanc*.

WHITE Film, or Blindness, a disease in sheep, which is occasioned by a white film growing over their eyes, in consequence of some sort of inflammation, as arising from different causes, taking place in them.

The appearances by which it is shewn to be present are, according to some, that the animal cannot bear the light, that the white part of the eye is red and inflamed, and that it waters a great deal. That this state is succeeded by a sort of membrane or coat formed by the inflamed vessels, which first covers the white, but gradually extends over the eye, until total blindness is the consequence. That this is noticed to be the case, when in folding, the sheep run against dykes, or any other such obstacles, and start when they approach them; that they do not follow the flock, and that they frequently stumble. That when the eye is inspected, it is ge-

nerally found, that a blue slough covers the whole of the eye, without any intermixture of red vessels. That in the worst cases, the coloured and transparent part of the eye becomes of a reddish-white; by which time, the film on the eye has acquired considerable thickness and hardness. That the inflammation is produced in various ways, and by various means; as during the summer season by the reflection of heat and light in very sunny and dry weather, as it is found to be more frequent when the hilly sheep-walks become scorched, and on hard rocky soils, than on the dark-coloured hills which are covered with heather. Others suppose, that the disease is sometimes caused by the pollen or dust of flowers irritating the eyes of the sheep, when blown into them, in considerable quantities, by the wind. That in the winter, the blindness is caused and occurs when the days are very sunny, and the evenings frosty and cold; or when the sheep have been long buried under snow, and the ground is still white and glaring when they get out.

But by still others, the blindness in sheep is believed to arise from a cause wholly different from any of these. That it is induced by a continued fatigue for a length of time, which is capable of bringing it on at any season of the year. Thus, sheep that are long and hard driven, or such as are daily dragged from one part of the ground to another, ewes that are *cild*, or old, and roughly handled and used by the women in milking, during the operation, where that practice is in use, and hog-sheep which are tired by driving through snow, in order to preserve their subsistence, are all liable to this affection of the eyes. That their eyes at first become sore, and emit a sort of rosy humour; after which a white film settles over them, and if they continue to be fatigued, it grows thicker, the eyes appearing perfectly white; in which cases, they are said to be proportionably longer in getting better. The disease, too, may proceed from many other causes of different kinds, as all such as tend to cause local inflammation in the parts, as cold, moisture, and many others of the same sort.

In the cure of the disease, where it is suspected to arise from the irritating powdery matter of flowers, the sheep should be immediately removed to other proper pastures for a time, until the danger from that cause is over; and in cases of snow-blindness of this kind, it is always proper to bring them down, as soon as possible, from the high snowy walks, where they occupy them, to the bare grounds below.

The inflamed vessels on the white of the eye, especially those next the nose, are also sometimes advised to be cut with a lancet or sharp penknife every second morning; while the eyes are to be kept defended against the light, by a shade tied over the head, or a piece of crape over the eyes. The eyes may likewise be bathed two or three times a-day, with a solution of half a drachm of sugar of lead, or of two drachms of alum, and the same quantity of white vitriol, in a pint of soft-water. At the same time purgatives may be given internally, such as two ounces of some purging salts, or, what is better, a scruple of calomel, once a day for four or five times. When, by these means, the inflammation is got the better of, but the slough still remains, a little ointment, composed of eight parts of some mild unctuous substance, and one of red precipitate of mercury, made fine by rubbing, may be insinuated into the eyes every morning; or a little finely powdered crystal and loaf sugar be blown into them twice in the day.

With some, it is at first the practice to bleed the sheep below the eyes, and to let some of the blood run into each of them; but it is supposed that care will infallibly cure the disease in a space of time proportioned to the debility that has

has induced the complaint without any thing else. The best and most proper means of cure in these cases are, in the first place, local or general bleeding, then the use of some such solutions and internal remedies as the above, after some time having recourse to stronger washes and powders of the same nature, with small quantities of opium, and keeping the animals all the while as much as possible from the light, and the glare of the ground. (See a paper in the third volume of the Transactions of the Highland Society of Scotland.) It is observed, that certain parcels of sheep are very liable to blindness of this sort, and that although it is not a fatal disease in itself, it frequently occasions considerable loss by the sheep drowning themselves, or breaking their necks in falling down precipices and other such places.

WHITE Flag, Flake, and Frost. See the substantives.

WHITE Foot, in the *Manege*, called in French *balzana*, is a white mark that happens in the feet of a great many horses, both before and behind, from the fetlock to the coffin. The horses thus marked are either tramelled, cross-tramelled, or white all four. Some horsemen place an unlucky fatality in the white of the far foot behind. See *CHAUSSE' Trop haut*, and *TRAMELLED*.

WHITE Friars, a name common to several orders of monks, from their being clothed in a white habit.

Such are, the regular canons of St. Augustine, the Premonstratenses, and Bernardines. See *CARMELITES*.

WHITE Glass. See *GLASS*.

WHITE-Hart Silver, candidi cervi argentum, a tribute or mulct paid into the exchequer, out of certain lands in or near the forest of White-hart, in Dorsetshire; which was continued from Henry III.'s time, who first imposed it upon Thomas de la Linde, and others, for killing a beautiful white hart, which that king had purposely spared in hunting.

WHITE Hellebore. See *HELLEBORE*.

WHITE Honeysuckle, in *Agriculture*, a term often applied to the white clover. It is stated, in the Agricultural Report for the County of Gloucester, to be a plant which is brought forward by manure and sheep-stock, and a proof of good land, at least of land in a high state of cultivation; and that, on this account, it has, when it abounds in dairy pastures, a tendency to raise the quality of the milk, and make the cheese more or heavier which is made from it. See *DAIRYING*, and *WHITE Clover*.

WHITE Horse-Fish, in *Ichthyology*, a common English name for the *raia aspera* nostras of Willughby, and the *raia fullonica* of Rondeletius and Linnæus. Its back is rough and spiny; the nose is short and sharp; at the corner of each eye are a few spines; the nictitating membrane is fringed; the teeth are small and sharp: on the upper part of the pectoral fins are three rows of spines pointing toward the back, and crooked, like those of the fuller's instrument; whence its name *fullonica* and *fuller*. On the tail are three rows of strong spines: the tail is slender, and rather longer than the body. The colour of the upper part of the body is cinereous, usually marked with many black spots; the lower part white. This fish grows to a size equal to that of the skate. Pennant.

WHITE Jasper, in *Mineralogy*, or agate jasper, has a pale yellowish-white colour, and sometimes occurs reddish-white. It is opaque, and has small imperfectly conchoidal fractures. See *JASPER*.

WHITE Land, in *Agriculture*, a tough clayey soil, naturally of a somewhat whitish hue when dry, especially when it has lain some time untilled, but becoming blackish after rain: this appears of a light greyish colour when turned up by the plough, and slides off from the plough-share with

ease, and with a smooth glossy surface. It has often a yellowish hue with the grey, and is often veined with large parcels of a blue marly earth. See *Clay SOIL*.

WHITE Lead is a sort of rust of lead, or lead dissolved with vinegar; much used by painters. See *LEAD*, and *CERUSE*.

WHITE Leaf. See *CRATÆGUS*.

WHITE Line, among *Printers*, a void space, greater than usual, left between two lines. See *PRINTING*.

WHITE Line, in *Anatomy*. See *LINEA Alba*.

WHITE Linnen is cloth of hemp, or flax, bleached by divers leys, and waterings on the ground.

WHITE Manganese, in *Mineralogy*, manganese oxydè carbonaté, Haüy. Red manganese ore of some mineralogists. This ore occurs of various colours, from yellowish-white to rose-red. See *Ores of MANGANESE*.

WHITE Meats include milk, butter, cheese, white pots, custards, and other foods consisting of milk, or eggs. Some add, also, fish, veal, and chickens.

WHITE Mortar. See *MORTAR*.

WHITE Must-Apple, in *Rural Economy*, a very fine cider-fruit in field fruit-grounds. This, with the fox-whelp, red-streak, and some others, are fine old fruits, but which are now going off, and afford the best cider, when mixed in the mill: the proportions in which they are to be used have never, however, been defined, but depend probably a good deal on the quantity to be ground at the same time.

WHITE Mustard, in *Agriculture*, a sort of plant which is often cultivated in the field for the use of the seed in different places.

The best sort of soil for it is that of the light loam, which should be well broken down and reduced by ploughing and harrowing. Some, on fresh broken up land, make a winter fallow for this crop.

It is mostly put in after a wheat-crop, but may succeed others where the land is clean and well prepared. In Kent, they strike furrows about eleven or twelve inches apart, and then sow the seed, two or three gallons to the acre, in the month of March.

The culture of it while growing is to hoe it, and keep it free from weeds, to set it out in the way of turnips, not too thick on the ground, as that draws up the plants weak. The crop is reaped about July. In some cases, it is laid in gavels or handfuls upon the stubble, in the same manner as cole-seed. It is usually threshed out on a sail-cloth in the field.

The produce differs from eight to twenty bushels the acre.

It is a ticklish sort of crop, as one frosty morning will kill it, and it is liable to be injured and eaten by the black caterpillar; but when it turns out well is very profitable.

It is said not to exhaust the land much, which is greatly in its favour.

WHITE Nebbed-Crow, a term provincially applied to the rook in some cases.

WHITE Order. See *ORDER*.

WHITE Paper is that intended for writing, printing, &c. in contradistinction to *brown paper*, *marbled paper*, *blotting paper*, &c.

WHITE, Pearl. See *PEARL*.

WHITE Pepper. See *PEPPER*.

WHITE Poplar, in *Agriculture*, a tree of the poplar kind, in which the wood is soft, but convertible to various uses in husbandry, as it grows quickly and bears cropping well. It is best grown in low situations, where the soil is of a clayey nature. It is sometimes called the abele tree.

WHITE Poppy, a plant sometimes cultivated in the garden and the field for the use of the opium which is obtained from its juice by means of evaporation. It might be largely cultivated in many situations with great advantage, as it contains this substance or principle in great abundance. See *PAPAVER Album*.

WHITE Porcelain. See *PORCELAIN*.

WHITE Pot, denotes milk or cream baked with the yolks of eggs, fine bread, sugar, and spice, in an earthen pot.

The cooks furnish us with a variety of dishes under this form and denomination: such are, Norfolk white-pot, Westminster white-pot, rice white-pot, &c.

WHITE Pottery. See *POTTERY*.

WHITE Precipitate. See *Carbonate of MERCURY*.

WHITE Pyrites, in *Mineralogy*; Fr. *sulfuré blanc*, Haüy. The colour of this ore when pure is of a tin-white colour, passing into brass-yellow and steel-grey. It occurs in small octohedral crystals variously modified, also stalactitical and botryoidal. It is hard, brittle, and easily frangible. It melts before the blow-pipe, giving out a sulphureous vapour; it then acts on the magnetic needle. It decomposes much easier than common pyrites. It contains 46 parts of iron and 54 of sulphur. See *PYRITES*.

WHITE Rent, in *Rural Economy*, a rent or duty of 8d. payable yearly, by every tinner in the counties of Devon and Cornwall, to the duke of the latter, as lord of the soil. See *BLANCH Fermè*.

WHITE Salt is common or sea-salt dried and calcined by the fire, so as not to leave any moisture therein. The chemists call it *decrepitated salt*.

There are some salts naturally white, and others that need to be whitened, either by dissolving and purifying them in fair water, which is afterwards evaporated; or by means of fire; or by the sun. See *SALT*.

WHITE Salt, a term applied to the fine purified salt, in contradistinction to that of the rock kind. The former is said in Cheshire to form a much more important object in the way of commerce than the latter. See *SALT*.

WHITE Sauce, a sort of sauce made of blanched almonds, and the breast of a capon, pounded together with cloves, cinnamon, &c. We also hear of white broth, which is a sort of broth enriched with sack and spices, having blanched almonds scraped into it, and the whole thickened with the yolks of eggs, &c.

WHITE Scour. See *SCOUR*.

WHITE Silver Ore, in *Mineralogy*, an ore of silver always associated with lead and antimony. (See *SILVER Ores*.) Dark white silver contains, according to Klaproth, 9.25 parts in the hundred of silver. Light white silver ore contains 20.40, associated with the same minerals as the dark ore, but in different proportions.

WHITE Soap. See *SOAP*.

WHITE, *Spanish*, is a kind of fucus used by the ladies to whiten their complexion, and hide the defects of it, called also *magistery of bismuth*.

The use of this, as well as of cerusses, is pernicious; and should be particularly avoided during the taking of any sulphureous water, which may change the complexion quite black. Indeed, all phlogistic vapours, and even the sun itself, tend to give both the magistery of bismuth and cerusse a yellow colour: an observation which serves to explain a passage in Martial, where a cerused lady is said to fear the sun.

“Cretata timet Fabulla, nimum,
Cerufata timet Sabella, solem.

Ep. lib. ii. Ep. 41.

WHITE, *Spanish*, is also a name given to troy white.

WHITE Spurs. See *SPUR*, and *ESQUIRE*.

WHITE Star, and *Sugar*. See the substantives.

WHITE Stone, in *Geology*; *Weiss stein*, Werner; *Eurite* of some French geologists; a rock enumerated by Werner as a distinct species among the primary rocks. It is essentially composed of felspar, but contains mica and other minerals. We think it may fairly be doubted whether white-stone ought to be considered as a distinct species of rock, or only as an occasional mode in which gneiss and granite sometimes occur. According to the account given by M. Bonnard of the Saxon Erzgerberge, in the *Journal des Mines*, 1815, the gneiss of that district often loses its mica, and passes into a rock essentially the same as white-stone or eurite. In other instances, the granite, by losing a great part of its mica and quartz, passes into the same rock, still retaining the geological position of granite, and including immense beds of granite within it. The north-western acclivity of the Saxon Erzgerberge is almost entirely composed of white-stone, including masses of granite, from a few feet to some miles in extent. This rock forms the basis on which the other rocks are placed. Bonnard gives the following description of white-stone or eurite in the above district:—It is composed of very fine granular felspar, which is sometimes compact, of a whitish-grey or yellowish-grey colour; the mica is brownish. It occurs in layers, and is sometimes fissile when the mica is abundant. In this case, the felspar is almost as friable as dolomite. When the felspar is compact, and the mica more rare, the rock nearly loses its fissile property. This rock contains fappare and other minerals disseminated. The rock on which it rests is unknown, as the white-stone serves as a basis for the gneiss and other rocks. In the greater part of the district a granitic rock occurs in the white-stone, which is sometimes a true granite and sometimes a granular eurite. This granite is composed of felspar, which is rarely of a red colour, but often brown, which is also generally the colour of the mica; the proportion of the quartz is variable, and sometimes is entirely wanting. In the few places where the two rocks can be seen together, the granite appears not only to alternate with the eurite, but to pass into it; or rather the two rocks may be said to pass insensibly into each other, both in the small and large masses. The grain of the granite is often very fine; but near Penig it contains crystals of felspar of a foot in cubic size. The only beds which occur in the white-stone are of serpentine; these are in the upper part of it, and dip to the north. There have been no metallic veins discovered in the white-stone rock. From the above description, there can be little doubt that white-stone ought, when viewed geologically on a large scale, to be considered only as a particular form of granite arising from the diminution of the quartz and mica. The circumstances, whatever they may have been, which first disposed the granite to solidify, permitted the constituent parts to arrange themselves in different proportions in various parts of the mass. Thus in extensive granite formations, nothing is more frequent than to see the quartz and felspar collected in large masses nearly pure, or with a very small admixture of the other component parts; and in the white-stone of Saxony precisely the same facts are exhibited on a larger scale. See *ROCKS, STRATA, and SYSTEMS of Geology*.

WHITE Styre Apple, in *Rural Economy*, a rich cider-fruit in field orchards. It is said to be the boast of the forest district in Gloucestershire, and that under proper management, it affords a cider so rich and strong, that it is often valued equally with foreign wine, and sold at extravagant prices.

WHITE-SWELLING.

WHITE-Swelling, in Surgery. When a disease is attended with great varieties, not only with regard to its progress and symptoms, but also its cause, and the disorder which it produces in the parts which are the seat of it, there is as much difficulty in fixing upon a name that will convey an exact idea of it, as in offering a definition or description of it applicable to all the cases which may present themselves to the attentive observer. Such are the circumstances of the disease of which we are about to speak in the present article. Surgeons have given it a variety of appellations, derived from some one particular symptom with which it is accompanied. Thus, it has been called *white-swelling*, (a name which is still most generally adopted,) because the skin which covers it retains its natural colour, and exhibits no appearance of inflammation. It is also sometimes termed *fungus articuli*, on account of its softness and elasticity, which allow it readily to yield to pressure, but make it rise up again immediately when the compression is discontinued, like the fungous excrescences which grow upon the oak. The disorder is likewise often named by foreign writers the *lymphatic tumour*, or *serous swelling of the articulations*, in consequence of the great quantity of thick lymph which appears to be effused in the cellular substance around the ligaments, and upon the ligaments themselves. Sometimes the disease is called *spina ventosa*. (See that article.) The case is occasionally denominated a *false ankylosis*, because the disease causes more or less interruption of the motions of the joint. Lastly, the distemper is often called a *rheumatic*, or *serofulous disease of a joint*, according as rheumatism, or scrofula, is suspected of being concerned in its origin.

White-swellings are usually defined to be chronic enlargements of the joints; circumscribed; without any alteration in the colour of the skin; sometimes hard, and resisting the pressure of the fingers; sometimes less firm, elastic, yielding to pressure, and afterwards rising up again in the manner of a fungus, which grows upon certain trees; sometimes so soft as to present a deceitful feel of fluctuation, although there is no fluid in the part. In particular instances, these swellings are indolent; but, most frequently, they are attended with great pain, especially when the joint is moved, so that the patient either cannot exercise the limb at all, or does it at the expence of considerable suffering, and with imperfection and difficulty. The disease has its seat in the ligaments, cellular substance, synovial glands, cartilages, and even the bones. All these parts, however, are not affected in every instance; and sometimes the distemper commences in the bones; sometimes in the cartilages and ligaments, according to the peculiarity in the nature of the case. The foregoing definition is obviously merely an enumeration of the principal symptoms of white-swellings, and is far from giving an exact idea of a disease which presents so many varieties in different individuals, that there are scarcely two patients to be met with in whom the complaint follows precisely the same course, or exhibits altogether similar phenomena.

There is no joint which may not be attacked by this inveterate disease; but experience proves, that the ginglymoid articulations are more frequently affected than the orbicular. We are, however, to except from this remark the articulation between the femur and os innominatum, in which the disease is very common, and often called by the French surgeons *spontaneous dislocation of the femur*, because the case generally terminates in a displacement of the head of the thigh-bone. (See *HIP-Joint, Disease of*.) Amongst the ginglymoid joints, the knee is oftener affected than any other. Then come the joints of the elbow, foot, and hand. White-

swellings attack the small joints, like those of the fingers and toes, with far less frequency.

White-swellings may occur at every period of life; but they are more common in infancy and youth than in adults and old subjects. It is conceived also by some writers, that these cases begin more frequently in autumn and winter, or when the atmosphere is damp and variable, than in the other seasons. But the disease is on the whole so common in this climate, that it must be difficult to establish the truth of the foregoing conjecture.

The disease sometimes begins with a more or less acute pain in the articulation, usually extending along the fasciæ and tendons of the neighbouring muscles. Sometimes the pain is of a dull kind, being superficial, seated in the soft parts, and reaching all round the joint. On other occasions, it is acute, deeply situated, and confined to a small space, which is mostly the very centre of the articulation. In particular examples, the swelling of the joint succeeds a pain which has been experienced in another part of the body, and suddenly ceased. Sometimes the disease begins in so unexpected a manner, that the patient, who went to bed perfectly well, rises in the morning with a stiff painful knee. Cases of the latter kind are generally rheumatic.

Whatever may be the manner in which the complaint originates, and whatever the circumstances which precede the attack, it always comes on in the form of a tumour, which presents the following characters:—The swelling seldom reaches all round the articulation; but is almost always limited to a more or less extensive portion of the circumference of the part. In the knee, it occurs above the patella, and also below this bone, at the sides of the ligament, which connects it with the tibia. In the elbow, it chiefly occupies the sides of the joint, especially the inner side. In the ankle, it takes place below and behind the malleoli. Lastly, in the fingers, it commonly affects the whole circumference of the diseased joint. Such swelling is circumscribed, immoveable, and more or less hard and elastic, not retaining the impression of the finger, as in œdema (see **ŒDEMA**), but generally communicating, when handled, a sensation of softness, which leads to a suspicion of the presence of a fluid, when none in reality exists. The swelling is more or less painful, especially when compressed. Sometimes, however, it is indolent; the heat of the part is not increased, and the integuments continue of their natural colour. The motion of the joint is impeded, and if the patient will not abstain from moving the part, he is put to excruciating pain. There are some white-swellings of the knee, in which the leg is fixed in the extended posture; but, most commonly, the limb is bent, even in a considerable degree, and when an endeavour is made to straighten it, great suffering is excited. In white-swellings of the elbow, the fore-arm is constantly observed in a state of flexion. In those of the wrist, the hand has a strong propensity to fall into the bent position; and in order to prevent this occurrence, and hinder an incomplete luxation of the carpus from taking place backwards, the surgeon is sometimes obliged to support the hand upon a splint.

The constant flexion of the limb produces a considerable retraction of the flexor muscles and their tendons, together with a rigidity which can be felt through the integuments, which are raised up by the sinews so affected. The total loss of exercise always arising from this state of the muscles and tendons, generally soon renders the joint stiff and motionless, so that it frequently has the appearance of being in a state of real and complete ankylosis. See **ANKYLOSIS**.

WHITE-SWELLING.

The swelling may remain a long while in the condition which has been described; it may even cease to be painful; and it may cause only a serious weakness of the knee, and more or less difficulty in walking. But most commonly it continues to make uninterrupted progress; or, if its advances should happen to be checked, and the disease be for a time stationary, it frequently occurs, that, in consequence of a fall, a bruise, or even without any external cause, and, as it were spontaneously, the complaint afterwards increases again. The articulation swells more and more, and, if it be the knee which is affected, the hollow of the ham also swells up and becomes effaced. The pain likewise augments, being felt sometimes at one point of the circumference of the joint, sometimes at another; occasionally in the ham, and, in other examples, in the very cavity of the articulation. There are, however, some patients who seem to suffer little or no pain of any consequence. The hardness of the tumour is subject to great variety. The older the disease is, the more considerable is in general the degree of induration. Yet there are certain white-swellings which are extremely hard, although they have not existed a long while; and other cases which are very soft, notwithstanding they are of long standing. Boyer thinks, that this difference depends upon the seat of the disease, which is sometimes in the bones; sometimes in the ligaments and surrounding cellular membrane. The skin which covers the swelling grows thin, pale, and shining; the cutaneous veins become dilated and varicose; and the muscles of the leg waste and dwindle away, so that the size of this part of the limb is strikingly diminished. Sometimes, however, it is affected with œdema, and has the appearance of being enlarged. The lower part of the thigh also frequently undergoes a very considerable diminution. This wasting of the limb above and below the disease, makes the joint also seem much more swelled than it is in reality. Sometimes the lymphatic glands in the groin become enlarged and hardened; and when the disease makes much progress, the bones are frequently softened and carious, and the cartilages destroyed. Lastly, abscesses, more or less considerable, are formed in different parts of the tumour; and their formation is attended with a great deal of acute pain, inflammation, and fever. These abscesses are more or less deeply situated, and often communicate with the interior of the joint. When they burst, or are opened, a large quantity of matter is discharged, which is hardly ever of healthy consistence, being mostly a sero-purulent yellowish fluid, somewhat resembling turbid whey, and containing flakes of albumen. Sometimes, however, it presents very nearly the appearances of healthy pus; but it soon changes into a thin fetid sanies of very bad quality. Its discharge, although very considerable, is followed by scarcely any perceptible diminution in the size of the swelling. The openings by which it escapes sometimes soon close, and fresh collections of matter ensue which burst of themselves, and then heal up like the former; but, in general, the apertures, instead of healing, become converted into incurable fistulæ.

Mr. Brodie has paid considerable attention to the several diseases of the joints, which usually go under the name of white-swelling. In particular, he has carefully examined the morbid appearances which are found upon dissection; and his observations have led him to propose a classification of these diseases.

1. The first case which Mr. Brodie describes is, *inflammation of the synovial membrane*, which may occur as a symptom of a constitutional disease, where the system is affected with rheumatism; where mercury has been improperly exhibited, or in large quantities; or where there is general debility

from any other cause. But, in these cases, the inflammation is seldom severe; it occasions an effusion of fluid into the joint, but rarely terminates in the extravasation of coagulating lymph, or thickening of the inflamed membrane. Sometimes it leaves one joint to attack another; or, it suddenly subsides without another joint becoming affected.

At other times, says Mr. Brodie, the inflammation occurs as a local affection produced by a sprain, the application of cold, or arising from no evident cause. It is then, for the most part, more severe, and of longer duration; it leaves the joint with its functions more or less impaired, and occasionally terminates in its total destruction. In itself, it is a serious disease; but it is often confounded, under the general name of white-swelling, with other diseases still more serious. In some cases, it assumes the form of an acute; but in the greater number of instances, it has that of a chronic inflammation.

When the case is acute, the skin is in general red, and the joint tender and painful. The pain, which is not confined to any particular point, and aggravated by motion of the limb, is soon followed by swelling. The patient is also affected with inflammatory fever. In a few days, the disease either subsides altogether, or assumes the chronic form.

According to Mr. Brodie, when the inflammation is chronic, the pain and tenderness are less, so that the patient is able to walk about, and often without experiencing any severe distress. There is no fever, and the skin retains its natural colour. The swelling also increases less rapidly than in acute cases. These symptoms are generally rendered worse by exposure to cold and exertions. In the first instance, the swelling of the joint arises entirely from a preternatural quantity of synovia. But when the inflammation has existed some time, the fluid is not so plainly perceptible, because the synovial membrane is now thickened, which likewise augments the stiffness of the articulation. The shape of the swelling is not that of the articulating ends of the bones, but arises chiefly from the distended state of the synovial membrane, and hence depends in a great measure on the situation of the ligaments and tendons, which resist it in certain directions. Thus, when the knee is affected, the swelling is principally observable in the same places where it occurs in cases of hydroys articuli.

After the inflammation of the synovial membrane has subsided, the fluid is absorbed, and, in some instances, the joint recovers its natural figure and mobility; but in the majority of cases, the stiffness and swelling continue. Whenever the patient is exposed to cold, or exercises the limb much, the pain returns, and the swelling is increased. Such cases are of frequent occurrence, and, as Mr. Brodie observes, they form a large proportion of those diseases which are called white-swellings.

Long-continued and neglected inflammation of the synovial membrane sometimes terminates in the formation of an abscess in the joint, in ulceration of the cartilages, and destruction of the articular surfaces. *Medico-Chir. Transf. vol. v. p. 240, &c.*

2. The same gentleman has favoured the public with a very circumstantial history of another description of cases, where the disease originates in the synovial membrane, which loses its natural organization, and becomes converted into a thick pulpy substance of a light brown colour, intersected by white membranous lines, and from one-fourth to one-half of an inch, or more, in thickness. As this disease advances, it involves all the parts of which the joint is composed, producing ulceration of the cartilages, caries of the bones,

bones, wasting of the ligaments, and abscesses in different places. The complaint has invariably proved slow in its progress, and sometimes has remained nearly in an indolent state for many months, or even for one or two years; but Mr. Brodie informs us, that he has never met with an instance in which a real amendment was produced, much less a cure. (See *Medico-Chir. Transf.* vol. iv. p. 220, &c.) Mr. Brodie also remarks, that the above-described affection of the synovial membrane is rarely met with, except in the knee, and that it generally takes place in young persons under, or not much above the age of puberty. In the origin of this disease, there is a slight degree of stiffness and tumefaction, without pain, and producing only the most trifling inconvenience. These symptoms gradually increase, so that, at last, the joint scarcely admits of the smallest motion, the stiffness being greater than what is the usual result of common inflammation. The form of the swelling bears some resemblance to that in cases of inflammation of the synovial membrane; but it is less regular. The swelling is soft and elastic, and gives to the hand a sensation as if it contained fluid. If only one hand be employed in making the examination, the deception may be complete, and the most experienced surgeon may be led to suppose that there is fluid in the joint when there is none; but if both hands be employed, one on each side, the absence of fluid is distinguished by the want of fluctuation.

“The patient experiences little or no pain, until abscesses begin to form, and the cartilages ulcerate; and even then the pain is not so severe as where the ulceration of the cartilages occurs as a primary disease, and the abscesses heal more readily, and discharge a smaller quantity of pus than in cases of this last description. At this period, the patient becomes affected with hectic fever, loses his flesh, and gradually sinks, unless the limb be removed by an operation.” See Brodie’s *Obs. in Medico-Chir. Transf.* vol. v. p. 251, &c.

3. Another form of white-swelling described by the same writer, is that which is more particularly characterized by ulceration of the articular cartilages. This change occurs in the advanced stage of several diseases of the joints, and it also exists in many instances as a primary affection, in the early stage of which the bones, synovial membrane, and ligaments, are in a natural state; but which, if neglected, ultimately occasions the entire destruction of the articulation. When ulceration of the cartilages occurs in the superficial joints, it constitutes one of the diseases which have been known by the name of white-swelling. From cases which Mr. Brodie has seen, he is led to conclude, that when it takes place in the hip it is this disease, which has been variously designated by writers, the “*morbus coxarius*,” the “*disease of the hip-joint*,” the “*scrofulous hip*,” the “*scrofulous caries of the hip-joint*,” &c. At least, Mr. Brodie conceives, that it is to this disease such names have been principally applied, though he acknowledges that there are probably other morbid affections which have been confounded with it. (*Op. Cit.* vol. iv. p. 236.) The ulceration of the articular cartilages takes place as a primary disease, chiefly in children or adults under the middle age. “Of sixty-eight persons affected with this disease, fifty-six (according to Mr. Brodie) were under thirty years of age: the youngest was an infant of about twelve months; the oldest was a woman of sixty.” As the knee is more frequently affected with inflammation of the synovial membrane, so is the hip more liable than other joints to ulceration of the cartilaginous surfaces. In general, the disease is confined to a single joint; but it is not very unusual to find two or three joints

affected in the same individual, either at the same time or in succession. Sometimes the patient traces the beginning of his symptoms to a local injury, or to his having been exposed to cold; but, for the most part, no cause can be assigned for the complaint. See *Medico-Chir. Transf.* vol. vi. p. 319.

For a description of the disorder as it occurs in the hip, the reader is referred to the article *HIP-Joint, Disease of*. At present, we shall merely notice the symptoms which, according to the investigations of Mr. Brodie, particularly characterize ulceration of the cartilages of the knee. They differ from the symptoms of inflammation of the synovial membrane, by the pain being slight in the beginning, and gradually becoming very intense, which is the reverse of what happens in the latter affection. The pain also in the commencement is unattended with any evident swelling, which never comes on in less than four or five weeks, and often not till after several months. It is not to be inferred, however, that every slight pain of the joint unaccompanied with swelling, must of course arise from ulceration of the cartilages. But, says Mr. Brodie, when the pain continues to increase, and at last is very severe; when it is aggravated by the motion of the bones on each other; and when, after a time, a slight tumefaction of the joint takes place, we may conclude that the disease consists in such ulceration. The swelling arises from a slight inflammation of the cellular membrane on the outside of the joint; it has the form of the articulating ends of the bones; and for the most part it appears greater than it really is, in consequence of the muscles being wasted. No fluctuation is perceptible, as where the synovial membrane is inflamed; nor is there the peculiar elasticity, which exists, where the synovial membrane has undergone a morbid alteration of its structure.

Mr. Brodie, however, has explained, that, in some cases, the swelling has a different shape, and communicates the feel of a fluctuation. This happens when inflammation of the synovial membrane, attended with a collection of the synovia of the joint, or abscesses in the surrounding soft parts, or in the articulation itself, occur as secondary diseases. When there has been considerable destruction of the soft parts from abscesses and ulceration, the head of the tibia may become dislocated and drawn towards the ham. See *Medico-Chir. Transf.* vol. vi. p. 326, &c.

4. There is another species of white-swelling which is peculiarly different from others, in being attended with ulceration of the synovial membrane. As, however, it does not appear to us to need a description in a work not expressly devoted to surgery, we shall only add, that the reader may find Mr. Brodie’s account of the case in the *Medico-Chir. Transactions*. Those white-swellings which are reputed to be scrofulous, form a subject, however, on which we cannot be silent. In the scrofulous diseases of the joints, the bones are primarily affected, in consequence of which ulceration takes place in the cartilages covering their articular surfaces. The cartilages being ulcerated, the subsequent progress of the disease is, according to Mr. Brodie, the same as where this ulceration takes place in the first instance.

It has been a very prevalent opinion, that, in cases of white-swelling, the heads of the bones are always enlarged. Mr. Russell is, perhaps, the first writer who expressed an opposite sentiment, and he absolutely declares, that he had never heard nor known of an instance, in which the tibia was enlarged from an attack of white-swelling. (*On Diseases of the Knee*, p. 37.) We believe, that a regular expansion
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of the heads of the bones, in cases of white-swelling, is far from being an usual occurrence, although it may sometimes happen. It is frequent, however, to meet with a sort of enlargement, which arises from spiculæ of bony matter, deposited on the outside of the tibia, ulna, &c., which alteration is materially different from a regular expansion of the heads of those bones. We have, however, lately seen an instance, in which the upper head of the ulna is considerably increased in size by a regular kind of expansion. The preparation is in Mr. Abernethy's museum; and a few other specimens have, we believe, been occasionally noticed. Yet, as a general fact, we may still remark, that an enlargement of the heads of the bones in the diseases called white-swelling, is far from being the usual state of things. The change which the head of the tibia undergoes in many cases, is first a partial absorption of the phosphate of lime throughout its texture, while a soft kind of matter is secreted into its substance. In a more advanced stage, and, indeed, in that stage which most frequently takes place before the limb is amputated, there are deep excavations in the head of the bone, arising from caries, and its structure is now so softened, that when a probe is pressed against the carious part, it readily penetrates deeply into the bone.

Mr. Brodie also joins in the opinion, that the morbid affection has its origin in the bones, "which," he says, "become preternaturally vascular, and contain a less than usual quantity of earth, while, at first, a transparent fluid, and afterwards a yellowish cheesy substance, is deposited in their cancelli. From the diseased bone, vessels, carrying red blood, shoot into the cartilage, which afterwards ulcerates in spots, the ulceration beginning on that surface which is connected to the bone." *Med. Chir. Transf. vol. iv. p. 272.*

With respect to the expansion of the heads of the bones, we ought to have mentioned, that the late Mr. Crowther entirely disbelieved the reality of the occurrence, and every body knows, that he paid very considerable attention to the subject. (See *Pract. Obs. on White-Swelling, &c. edit. 2. p. 14.*) The event, however, should have been described as unusual, and not as never happening, since, as we have already stated, a few specimens of such a change have now been collected.

Mr. Russell has particularly noticed how much the soft parts frequently contribute to the swelling: "the great mass of the swelling," he observes, "appears to arise from an affection of the parts exterior to the cavity of the joint, and which, besides an enlargement in size, seem also to have undergone a material change in structure. There is a larger than natural proportion of a viscid fluid, intermixed with the cellular substance; and the cellular substance itself has become thicker, softer, and of a less firm consistence than in a state of health." (*On the Morbid Affections of the Knee, p. 30.*) The manner in which the soft parts are affected is also described by Mr. Brodie. "Inflammation takes place of the cellular membrane, external to the joint. Serum, and afterwards coagulable lymph, are effused; and hence arises a puffy elastic swelling in the early and an œdematous swelling in an advanced stage of the disease. Scrofula attacks only those bones, or portions of bones, which have a spongy texture, as the extremities of the cylindrical bones, and the bones of the carpus and tarsus; and hence the joints become affected from their contiguity to the parts which are the original seat of the disease." *Med. Chir. Transf. vol. iv. p. 273.*

All white-swellings which make considerable progress, and occasion severe pain, long confinement, abscesses, &c.

unavoidably bring on that impairment of the general health, which is well known by the name of hectic fever. The patient gradually loses his appetite and natural rest and sleep; his pulse is small and frequent; an obstinate debilitating diarrhœa, and profuse nocturnal sweats, ensue. Such complaints are sooner or later followed by dissolution, unless the constitution be relieved in time, either by the amendment or removal of the diseased part. In different patients, however, the course of the disease, and its effects upon the system, vary considerably in relation to the rapidity with which they occur.

Rheumatic white-swellings are very distinct diseases from the scrofulous distemper of the large joints. In the first, the pain is said never to occur without being attended with swelling. Scrofulous white-swellings, on the other hand, are always preceded by a pain, which is particularly confined to one point of the articulation. In rheumatic cases, the pain is more general and diffused over the whole joint.

It seems probable, that all cases in which the structure of the bones is found quite undiseased, and in which all the marks of disease appears to be confined to the soft parts, are not scrofulous white-swellings. Few persons who have attained the age of five-and-twenty, without having had the least symptom of scrofula, ever experience, after this period of life, a first attack of the white-swelling of the stumous kind. All cases, in which the internal structure of the heads of the bones becomes softened, are probably scrofulous.

Mr. Russell has noticed the frequent enlargement of the lymphatic glands in the groin, in consequence of the irritation of the disease when in the knee; but, he justly adds, that this secondary affection never proves long troublesome.

When the bones are diseased, the head of the tibia always suffers more than the condyles of the thigh-bone. (*Russell.*) The articular surface of the femur sometimes has not a single rough or carious point, notwithstanding that of the tibia may have suffered a great deal. The cartilaginous coverings of the heads of the bones are generally eroded first at their edges; and in the knee, the cartilage of the tibia is always more affected than that covering the condyles of the thigh-bone. Indeed, when white-swellings have their origin in the bones, and the knee is the seat of the disorder, there is some ground for supposing that it is in the tibia that the morbid mischief first commences.

The ligaments of the knee are occasionally so much weakened or destroyed by this terrible malady, that the tibia and fibula become more or less dislocated backward, and drawn towards the tuberosity of the ischium, by the powerful action of the flexor muscles of the leg.

We have seen a curious species of white-swelling, in which the leg could be moved to each side a very considerable distance, both when the knee was extended and bent. Such a state implies a preternatural looseness of the ligaments of the articulation.

Scrofulous white-swellings, no doubt, are under the influence of a particular kind of constitution, termed a scrofulous or stumous habit. In this sort of temperament, every cause capable of exciting inflammation, or any morbid and irritable state of a large joint, may bring on such disorder as may end in the severe disease of which we are now speaking.

In a man of a sound constitution, an irritation of the kind alluded to might only induce common healthy inflammation of the affected joint.

In scrofulous habits, it also seems probable, that irritation

tion of a joint is much more easily produced than in other constitutions; and no one can doubt, that when once excited in the former class of subjects, it is much more dangerous and difficult of removal than in other patients.

The doctrine of particular white-swellings being scrofulous diseases, is supported by many weighty reasons, the opinions of the most accurate observers, and the evidence of daily experience. Wiseman (book iv. ch. 4.) calls the *spina ventosa* a species of scrofula, and tells us, that infants and children are generally the subjects of this disease. The disorder is said by Severinus to be exceedingly frequent in young subjects. Petrus de Marchettis has observed both male and female subjects affected with what are called strumous diseases of the joints, as late as the age of five-and-twenty; but not afterwards, unless they had suffered from scrofula before that period of life, and had not been completely cured. R. Lowerus also entertains a similar opinion. Even though a few persons may have scrofulous diseases of the joints, for the first time, after the age of twenty-five, this occurrence, like the first attack of scrofula after this period, must be considered as extremely uncommon.

Another argument in favour of the doctrine, which sets down particular kinds of white-swellings as scrofulous, is founded on the hereditary nature of such forms of disease.

Numerous continental surgeons, particularly Petit and Brambilla, have noticed how very subject the English are both to scrofula and white-swellings of the joints. We every day see, that young persons afflicted with the present disease, are generally manifestly scrofulous, or have once been so. Very often enlarged lymphatic glands in the neck denote this fatal peculiarity of constitution; very often the patients are known to have descended from parents who had strumous disorders. Crowther.

Besides the general emblems of a scrofulous constitution, we may often observe a shining, coagulated staky substance, like white of egg, blended with the contents of such abscesses as occur in the progress of the disease. This kind of matter is almost peculiar to scrofulous abscesses, and forms another argument in support of the foregoing observations relative to the share which scrofula frequently has in the origin and course of many white-swellings. Cooper's Dict. of Practical Surgery.

The causes of white-swellings are divided by surgical writers into external and internal. Amongst the former are reckoned mechanical injuries of the joints, such as wounds, contusions, sprains, immoderate exercise in cold damp weather, residing continually in a low humid situation, &c. It is certain, however, that these tumours are seldom produced altogether by external causes; and even when their formation has been preceded by some external violence, this is rather to be regarded only as the determining cause of the disease, while the real cause in this, as well as in other cases where the complaint begins spontaneously, is of an internal kind. Rheumatism and scrofula are the ordinary causes of white-swellings; and it may be alleged, without risk of error, that more than three-fourths of these tumours are owing to these constitutional diseases. Those white-swellings which attack strong plethoric subjects of adult age, commonly depend upon rheumatism; while other cases which happen in children, are almost always caused by scrofula. It is well known that rheumatism is particularly disposed to make its attack upon the large joints, and that it especially affects the ligaments and neighbouring cellular substance, which it thickens and hardens, by causing an effusion of coagulable lymph. Hence, says Boyer, in

such white-swellings as arise from rheumatism, these parts alone are found diseased in the early stage of the complaint. *Traité des Mal. Chir.* t. iv. p. 501.

With respect to scrofula, every surgeon is aware that it frequently attacks the heads of the bones, particularly in children, occasioning those morbid changes which we have already endeavoured to describe. We have likewise mentioned what is now generally admitted, that in white-swellings originating from scrofula, the disease commences in the bones, the soft parts becoming affected only secondarily. The contrary is said to happen in all rheumatic cases, the disease beginning in the soft parts, and only affecting the bones in a subsequent advanced stage of the complaint.

The prognosis in cases of white-swelling is, generally speaking, unfavourable; but it is more or less so, according to the cause of the disease, its duration, the accompanying symptoms, the patient's constitution, &c. White-swellings arising from rheumatism are the least alarming, especially when they are recent. The progress of the complaint may then be often stopped, and sometimes a perfect cure accomplished. In this kind of case, the joint sometimes returns to its natural state, and regains the power of freely performing every motion; while in other instances, it continues affected with a greater or lesser degree of stiffness. White-swellings, which appear to depend altogether upon an external cause, in persons in other respects healthy and sound, may terminate well. The worst white-swellings of all are those which originate from scrofula; for they are very seldom cured, and when they do admit of amendment, the joint is always left in a state of ankylosis.

Whatever may be the cause of white-swellings, when they are of long standing, severely painful, the bones softened and rendered carious, the cartilages ulcerated, the articulation filled with sanious matter, and abscesses have formed, the openings of which continue fistulous, and emit a more or less abundant quantity of a thin fetid discharge, the disease is in general incurable. In this case, the violence of the pain, the hectic fever, the profuse sweats, and colliquative diarrhoea, plunge the patient into a state of marasmus, and soon carry him off, unless an attempt be made to save him by the timely performance of amputation. Yet, as Boyer observes, in some few cases of this hopeless description, nature, skilfully assisted by art, has been known to subdue the disease. The suppuration then gradually diminishes and assumes a better quality, the slow fever, nocturnal perspirations, and weakening diarrhoea, entirely cease, the appetite returns, digestion is well performed, the strength is restored, and the patient gets well with an ankylosis. But such fortunate cases are extremely uncommon, and they do not justify us in leaving the disease to nature, instead of amputating the limb. *Traité des Mal. Chir.* t. iv. p. 505. 507.

Of all the diseases which fall under the care of the surgeon, there is not one in which a greater variety of remedies has been proposed than in white-swellings. Yet, notwithstanding the numerous means which are occasionally tried, the practitioner frequently has the mortification of finding, not only that he cannot accomplish a radical cure, but that he cannot even palliate the complaint, moderate its violence, or retard its progress.

The surgeon, in order to be methodical, should adapt the treatment to the particular form of the disease and its different states. But, in every instance, perfect rest of the limb is absolutely indispensable, as exercise always has the effect of keeping up pain and irritation, and doing harm, whatever may be the species of the disease.

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Rheumatic white-swelling being invariably accompanied, at their commencement, with an inflammatory character, there can be no doubt, that, at this period of the complaint, the great indication is to take such measures as are best calculated to lessen and subdue inflammation; and bleeding is what should first be practised. When the patient is strong, robust, and much fever exists, he may be bled once or twice in the arm; but, in other cases, we are to be content with drawing blood from the part affected with leeches, or by cupping. If leeches be used, they should be applied to both sides of the joint, and eight or ten ounces of blood ought to be thus taken away. The application of these animals should also be repeated at proper intervals, more or less frequently, according to the violence of the symptoms, and the strength of the patient. In cases of this description, drawing blood from the diseased part itself is found to be much more efficacious than general blood-letting, which weakens the patient without proportionately lessening the swelling of the joint.

Blisters are another means, as efficacious as topical bleeding. Boyer recommends beginning with the application of a small one to the front of the joint, where the leeches have not been put; and he says, that it should be kept open, until the bites of the leeches are healed on one side of the articulation, where a second blister is then to be applied. As soon as this is nearly healed, we are next advised to lay a third blister on the opposite side of the joint. By thus continually changing the situation of the blister from one side of the articulation to another, a permanent counter-irritation is kept up, which, says Boyer, in all deeply-seated inflammations, especially those which proceed from rheumatism, is much more effectual, than carefully maintaining a discharge from a single blister.

In conjunction with the foregoing means, the limb should be kept moderately and uniformly warm by covering it with flannel; a low diet is to be observed, cooling beverages prescribed, and the action of the bowels regulated by clysters. Thus, the severity of the pain may generally be lessened, and the inflammation diminished. If the pain, however, should still continue to be violent, Boyer recommends the use of topical anodyne and narcotic applications. He states, that, in this circumstance, he has often employed with success opiate and camphorated liniments; fomentations composed of a solution of the extract of opium in water; a strong decoction of poppies, &c. He thinks, however, that such applications should never be used, unless the pain be very severe.

When the inflammatory stage is over, topical resolvent remedies are to be employed, and their effect is to be promoted by exhibiting mild opening medicines at suitable intervals. The most effectual resolvent applications, and those which are most commonly tried in these cases, are, dry frictions with a piece of flannel, impregnated with the vapour of benzoin, liniments containing ammonia and camphor, ammoniacal plasters, soap-liniment, lotions of vinegar, spirit of wine, and the muriate of ammonia, &c. Mr. B. Bell had a very high opinion of the good effects of rubbing the joint with camphorated mercurial ointment; but Boyer affirms, that he has often tried the last application, and that his experience leads him to impute whatever benefit arises from its employment, chiefly to the frictions, which redden and promote the circulation in the skin.

By a perseverance in the judicious use of the means above specified, rheumatic white-swelling may sometimes be cured; but it often happens, that, after the pain and swelling have subsided, the joint remains quite stiff and

motionless, and every attempt to move it causes considerable suffering. In the majority of cases, such stiffness depends almost entirely upon the retraction of the muscles, tendons, and ligaments, and demands the same treatment as a false ankylosis. See ANCHYLOSIS.

When the disease resists the foregoing treatment, and is of long standing, the cure is more difficult, inasmuch as the thickening of the ligaments, and the effusion of a sero-albuminous fluid into the cellular substance around them, are more considerable, and the bones and cartilages are likewise at the same time affected. In this circumstance, if there be any hope of cure, the surgeon must have recourse to more powerful means, which we shall mention in speaking of the treatment of other descriptions of white-swelling.

In white-swelling, arising from an external cause, such as blows, falls, &c. we must first lessen the inflammation by general and local bleeding, low diet, cooling aperient beverages, fomentations, and emollient anodyne poultices. Afterwards, when the pain and tension have subsided, resolvent applications are to be used, and the patient is not to be allowed to move the limb, as long as there is any danger of a renewal of the pain and irritation by exercise.

Scrofulous white-swelling in an early stage present different indications, according to the circumstances with which they are accompanied. A fall, or blow upon a joint, being sometimes the exciting cause of these tumours, any accident of this kind in a person evidently disposed to scrofula demands the utmost attention and care. No means should be neglected which are at all likely to lessen the pain and irritation in the affected joint, and in particular the limb ought to be kept perfectly quiet for a long time. Scrofulous white-swelling frequently come on, as it were, spontaneously, without the concurrence of any external accident, and their attack is attended with a dull, sometimes an acute pain in the very cavity of the joint, which at first is not affected with any manifest degree of swelling. In this circumstance, the surgeon must endeavour to prevent the progress of the disease by enjoining the patient to refrain from moving the joint, and by directing the employment of soothing local applications, which are afterwards to be succeeded by blisters, or an issue.

In the cases of white-swelling, which appear from Mr. Brodie's account to depend principally upon inflammation of the synovial membrane, the acute stage of the disease is to be treated by general and local bleeding, aperient medicines, cold topical applications, or fomentations, and emollient poultices. When the affection has become chronic, this gentleman recommends perfect rest, and leeches, or cupping, followed by the application of a large blister. Under this treatment, he says, "the pain is relieved, and, in a few days, the swelling, as far as it depends upon the fluid collected in the cavity of the joint, is much diminished. Even where the tumour is solid, arising from the effusion of coagulating lymph, it will in a great measure subside, and sometimes be entirely dispersed, provided the lymph has not yet become organized. A single blister often produces marked good effects; but, it is generally necessary to repeat both the blister and the blood-letting several times." Mr. Brodie considers the repeated application of blisters more efficacious, than a single blister kept open with the avine cerate. When the inflammation has been much subdued, he thinks moderate exercise of the joint rather beneficial, and commends the use of a stimulating liniment, composed of $\frac{3}{4}$ ss of olive oil, and $\frac{3}{4}$ ss of sulphuric acid. This application, when too irritating, is to be weakened by an additional quantity of oil, and it is not to be used before inflammation

inflammation is subdued, lest it aggravate the disease. Issues and setons, which are useful in ulceration of the cartilages, Mr. Brodie deems useless in the present disease. Plasters of gum ammoniac, and others of a similar nature, are of little efficacy while inflammation exists, but afterwards they are of use in guarding the joint from the influence of external cold, and preventing a relapse. For the removal of a moderate degree of swelling and stiffness, left by the past inflammation, Mr. Brodie entertains a favourable opinion of exercise of the limb, and friction with camphorated mercurial ointment, or by the hand with finely powdered starch. When the friction, however, produces inflammation again, it is to be discontinued, and leeches applied. When the swelling and stiffness are considerable, Mr. Brodie has never seen friction do much good, and, as it is in such cases particularly apt to bring on inflammation again, it is to be employed with much caution. According to the same author, friction is more efficacious, where the stiffness of a joint depends on a contracted state of the muscles, or tendons of the limb, or on these being glued to each other, or the surrounding parts, than where it is the consequence of disease of the joint itself. In some cases, the pumping of warm water on the part, from a height of several feet, as practised at some of the watering places, is beneficial; but in this plan, the same cautions are necessary, as in the employment of friction.

With regard to the cases which Mr. Brodie describes as depending upon a total loss of the natural structure of the synovial membrane, which is converted into a pulpy substance, one-quarter, or one-half, of an inch in thickness, are, according to this gentleman, quite incurable, and they at length terminate in ulceration of the cartilages, abscesses, &c. Hence, when the health begins to suffer, he considers amputation proper. See *Medico-Chir. Trans.* vol. v.

When white-swellings are accompanied with ulceration of the cartilages, all motion of the joint is extremely hurtful. Indeed, as Mr. Brodie well observes, keeping the limb in a state of perfect quietude is a very important, if not the most important circumstance to be attended to in the treatment. According to the same writer, it is in these cases, in which ulceration of the cartilage occurs as a primary disease, that caustic issues are usually productive of singular benefit; but he deems them of little use in any other diseases of the joints. He thinks setons, and blisters kept open with the favine cerate, may also be used with advantage in the same description of cases. Bleeding can only be proper, when, from the bad effects of exercise, the articular surfaces are inflamed, and pain and fever prevail. Mr. Brodie assures us, that the warm-bath relieves the symptoms in the early stage, if it does not stop the progress of the disease; but he condemns plasters of gum ammoniac, embrocations, liniments, and frictions, as either useless or hurtful. *Op. Cit.* vol. vi.

The pumping of warm water upon diseased joints is a method which is at present very frequently adopted, as more conceive, with decidedly beneficial effects. The plan is not altogether modern. Le Dran, and several other old practitioners, recommend throwing warm water upon diseased joints, and they prove the advantages of this treatment by a relation of many successful cases. In order to derive the greatest possible good from the plan, the water should be as warm as the patient can bear it, and it ought to fall upon the part from a height of seven or eight feet. The size of the stream must also vary according to the degree of sensibility in the tumour. When the pain is acute, the end of the pipe must be closed with a piece of tin, perforated by many holes, like the spout of a watering-pot. But when

the pain is inconsiderable, the pipe may terminate in a single opening, the diameter of which should vary from half an inch to an inch, according to circumstances. The application is sometimes to be continued nearly an hour, and when it is finished, the patient ought to go to bed, and the joint be covered with bladders filled with water as hot as the patient can bear. Boyer recommends the application of the bladders to be persevered in for the space of two hours, after which they are to be removed, and perspiration from the part promoted by covering it with warm cloths, or flannels. In the evening, the bladders are to be repeated for some hours. The dashing of warm water against the diseased joint is to be practised every day, or every other day, according as the patient can bear the plan, without too much fatigue or inconvenience. This treatment, says baron Boyer, is proper in all kinds of white-swellings, and in every stage of the disease; but it is much the most useful in those cases in which the soft parts alone are affected, and at an early period, before the complaint has made great progress. Favourable effects may be expected from this method, when, after each application of the water, the part affected perspires copiously, when it grows gradually softer, and when, after a certain number of trials, the swelling begins to diminish. Under these circumstances, the plan is to be continued and repeated very often, as a long perseverance in it has frequently produced extraordinary cures. When none of the above-described changes happen, little benefit can be hoped for from the method; but still the patient should not abandon it, before its inefficacy has been proved by adequate trials.

When there is no suitable apparatus for applying the warm water, it may be injected against the part with a large syringe, which has a pipe about half an inch in diameter made with four or five holes, for the discharge of the fluid. The injections may be rendered more or less active, by compelling the water with more or less force.

These affusions operate only by the heat and strength of the current of water. Boyer states, that their activity may be augmented by adding to the fluid a quantity of the muriate of soda or muriate of ammonia, or some potassa or soda; and he thinks it still better to employ a sulphuretted mineral water, either natural or factitious. The activity of the affusions may also be increased by heating the water to a high temperature, letting it fall from a considerable height, and making the stream large. It is a plan, says baron Boyer, adapted to those white-swellings which are situated in the soft parts on the outside of the joints; and which are indolent, and unattended with much pain. When these active affusions are applied to white-swellings which are painful, and which affect the bones, they often increase the patient's sufferings, and accelerate the progress of the disease. See *Traité des Mal. Chir.* tom. iv. p. 512, &c.

Of late years, surgeons have frequently made trial of dry-rubbing, as it is termed, or friction of the joint, performed with the hand, for several hours a day, with the mere application of a little powdered starch, or hair-powder, in order to prevent the part from being chafed. It is a method which was first practised to a considerable extent at Oxford, and with great success. Many poor women there earned a livelihood by rubbing diseased joints at the rate of sixpence *per* hour. Indeed, there can be no doubt, that, in indolent rheumatic white-swellings, simple friction often removes the swelling in an expeditious manner, as well as the stiffness of the affected joint. The plan, however, will not effect a cure in scrofulous cases; nor can it be adopted without manifest

harm in any examples, in which the disease is either in an inflamed or irritable state.

In chronic cases, the swelling may also be lessened, and the complaint sometimes much benefited by pressure, made either with strips of adhesive plaster, or with bandages. This method will not do much good in instances where the bones are diseased, nor is it applicable to cases which are irritable, or attended with heat and inflammation.

For scrofulous white-swelling, surgery cannot yet be said to have discovered any effectual or certain means of relief; and these melancholy diseases frequently compel the patient to submit to amputation, as the only thing by which a long train of sufferings can be arrested, and the term of life extended. The common plan of treating scrofulous white-swelling is, by topical bleeding, fomentations, and cold applications, when they are attended with much pain, heat, and irritation; and by issues, setons, and blisters, in other periods of the disease. The cautery and moxa have also been much employed abroad; and, as every body knows, they were favourite and powerful remedies in the hands of the ancients. In this country, the use of actual fire in surgery is nearly, if not quite, exploded, on the ground that its employment is attended with an appearance of cruelty, and that issues, made with caustic, are equally efficacious. Pouteau, an eminent French surgeon, will ever be famous for having revived in his own country all the ancient partiality to burning irons. He recommended their use for all white-swellings without discrimination; and the accounts which he has left of the success of the practice are surprising, if not incredible. In fact, they are in all probability great exaggerations; for we find that baron Boyer, one of the most eminent surgeons at Paris at the present time, decidedly declares his opinion, that Pouteau's descriptions of the efficacy of the actual cautery in the cure of white-swellings do not correspond with the results of modern experience. Boyer himself gives a preference to the moxa, which is a cone of cotton, burnt upon the diseased part, so as to produce an eschar. We confess, that to us this plan seems to have no material difference from the cautery; and, what is it but the application of actual fire in another form? Indeed, one cannot help thinking, that Boyer decries the cautery, only for the purpose of afterwards recommending the moxa, which is now a more fashionable means employed in French surgery. It is curious to find Boyer particularly forbidding the use of issues, and the moxa in cases of white-swelling, where the bones and cartilages are diseased; the very cases in which Mr. Brodie, in common with the generality of surgeons in England, expressly recommends either issues or perpetual blisters. Boyer has never seen much good arise from issues in any cases, although, as he affirms, he has made extensive trial of them. The time also when he thinks the moxa useful, is in that stage of the complaint which intervenes between the prevalence of inflammatory symptoms, and the commencement of disease in the bones and cartilages. Sometimes, however, the disorder certainly has its very origin in the bones themselves.

The late Mr. Crowther introduced the plan of keeping open blisters with the favine cerate, which is a method frequently attended with great success in chronic white-swellings, and sometimes appears to check the progress of the scrofulous form of the disease. Blisters may be kept open with this ointment a long time, and with less pain, than what proceeds from the use of the unguentum lyttæ, and other stimulating dressings. It also occasions no risk of bringing on strangury, or inflammation of the bladder and urinary organs, like the use of ointments containing can-

tharides. In our opinion, Mr. Crowther had much merit in making known the eligible qualities of the favine cerate; and, we believe, no better application for keeping up a discharge from blisters will ever be found out. Sometimes, however, the repeated application of blisters has more effect upon white-swellings, than a single blister kept open. This is a circumstance which the practical surgeon ought constantly to remember.

We might enlarge this article with observations on issues and setons, which are frequently employed in these cases; but it would be superfluous, as they have been already described in other parts of the work. See *ISSUE*, and *SETON*.

It may be supposed, that scrofulous white-swellings will require the exhibition of the remedies usually administered in cases of scrofula. (See *SCROFULA*.) Boyer, and some other writers declare, that this is actually the case. We have never seen these remedies, however, do any good to diseased joints, if we except sea-air, sea-bathing, and the use of sea-water lotions and poultices, which sometimes prove useful.

After all, we must acknowledge that white-swellings, we mean particularly the instances accompanied with ulceration of the cartilages, and disease of the heads of the bones, are cases which too generally baffle the utmost skill, and render a formidable operation unavoidable.

WHITE Tail. See *MOTACILLA Ceanothe*.

WHITE Tartar. See *TARTAR*.

WHITE Thorn. See *CRATÆGUS*.

WHITE Thorn, or Hawthorn. See *HEDGE*, and *QUICK-SET-Hedge*.

WHITE Thorn Layer, a term applied to such plants of the white thorn kind as are laid down in hedges to grow, in the operation of plashing. Also to the young roots of this thorn used in raising this sort of hedges. See *PLASHING Hedges*.

WHITE-Throat, in *Ornithology*, the name of a small bird, very common in our gardens and hedges, and seeming to have been described under the name of *spipola* by Aldrovandus and some others, though most approaching to the *ficedula* class.

Its beak is black above, and whitish below; its feet of a yellowish-brown; its neck and back are of a brownish-grey; its head more grey than either, and the upper part of the throat white, the rest reddish; its breast and belly are also a little reddish; but in the female, the breast is perfectly white. The edges of the long wing-feathers are some whitish and others brownish, and the tail is variegated with black and white, and some grey or ash-colour intermixed. It is extremely common in our gardens and orchards in summer, and feeds on flies, spiders, and other insects, but leaves us in winter. It builds in bushes, at a small height from the ground, with stubble and horse-hair, and lays five brownish-green eggs, with black spots. Its note is continually repeated, and often attended with odd motions of the wings: it is harsh and displeasing. This bird is shy and wild, and seems of a pugnacious disposition. Ray and Pennant. See *MOTACILLA Sylvia*.

WHITE Trefoil, in *Agriculture*, is said, in the third volume of the *Essays of the Highland Society of Scotland*, to be a humble but sweet plant, which delights in a dry sound field, properly cleaned and limed; and is alone the delight of sheep. But that a mixture of it, and of the seeds of rye and rib grass, constitutes one of the best sheep-pastures that can be formed by the industry of man. That this sort of grass is likewise perennial, and that it enriches instead of impoverishing the soil or land. This has generally been

noticed to be the most abundant plant in such rich improved pastures; but that it has seldom been seen in lands remarkable for inducing the rot among sheep. See ROT, SHEEP, and WHITE Clover.

WHITE, *Troy*. See TROY-White.

WHITE *Varnish*, and *Vitriol*. See the substantives.

WHITE *Vitriol*, in *Mineralogy*, a natural salt or ore of zinc. (See ZINC, and ZINC Ores.) This ore is a sulphate of that metal, but is frequently combined with a small portion of manganese. It is supposed to be formed naturally by the decomposition of blende or sulphuret of zinc.

WHITE-*Washing*, *Roughcast*. See WASH for, &c.

WHITE *Water*, a disease in *Sheep*, of the dangerous stomachic kind. It is said to be caused by their feeding on rich succulent food in cold frosty seasons, or at other times, and by many other such causes; and is probably an affection of the inflammatory kind.

It is remarked in the Gloucester Report on Agriculture, that the white water is a destructive disorder on the Cotswolds; usually comes on with rapidity, and sometimes terminates with death in three hours. It is supposed to be owing to their licking up the white frost on their green food in spring and autumn. Folding at night on bare ground, giving them dry meat in the morning, and keeping them from the turnips till the frost is gone, is the obvious mode of prevention, if the foregoing cause be well founded. If, however, the disorder be owing to gorging themselves with watery food, such as turnips, it is probable that to keep them moving, without suffering them to rest long, nor swell with what they have eaten, will carry off the beginning complaint; and even if the white frost has been the occasion, this is the best remedy that reasoning suggests; and it is said to be the practice of the shepherds in Northumberland, in the management of sheep under this complaint.

It is probable that speedy evacuation, both by bleeding and purging, may be found useful in this disease, and afterwards the use of stomachic remedies.

It is found to chiefly attack the young healthy sheep. See WATER, *Red and Black*.

WHITE *Water-Lily*, in *Gardening*, a most beautiful plant of this country, which is capable of being propagated in artificial and ornamental pieces of water in gardens and pleasure-grounds, merely by transplanting the bulbous roots of it in the winter season. It is perennial in its nature.

WHITE *Wax* is yellow wax blanched, and purified by the sun and dew. See WAX.

WHITE *upon White*, in the *Porcelain Manufactory*, a name given by the English merchants to a particular china-ware, which is formed of three different white substances, the body being of one, the flowers of another, and the varnish which covers these of a third. See HOACHE.

WHITE *Wine* is that of a clear, bright, transparent colour, bordering on white. It is thus called to distinguish it from the red wines, or clarets.

The generality of white wines are made from white grapes; though there are some from black ones, only the skins are carefully kept from tinging them. See WINE.

WHITES, the popular name of a disorder incident to women. See FLUOR *Albus*.

WHITE, in *Geography*, a county of West Tennessee, with 4028 inhabitants, including 283 slaves.

WHITE *Bay*, a bay on the east coast of Newfoundland. N. lat. 50° 10'. W. long. 56° 25'.—Also, a bay on the east coast of Kerguelen's Land, south of Point Pringle, so called from some white spots of land or rocks. In the

bottom are several smaller bays or coves. S. lat. 47° 53'. E. long. 69° 15'.

WHITE *Bear Lake*, a lake of North America, said to be the most northerly of those lakes which supply the Mississippi. It is about 60 miles in circumference. N. lat. 46° 50'. W. long. 95° 30'.

WHITE *Cliff*, or *Culver Cliff*, a cape of the east coast of the Isle of Wight. North of it is a bay called White Cliff Bay. N. lat. 50° 39'. W. long. 0° 56'.

WHITE *Deer*, a township of Pennsylvania, in North Cumberland county, on the Susquehanna, with 1132 inhabitants.

WHITE *Flag Bay*, a bay on the west coast of the island of St. Christopher; 2 miles N. of Sandy Point.

WHITE *Head*, a cape of Ireland, on the coast of Antrim, at the entrance into Belfast Lough, a little to the south of Black Head.

WHITE *Hills*, a fishing-town of Scotland, in the county of Bamff, situated in a creek; 2 miles N. of Bamff.

WHITE-*Horse Vale*, a vale of Berkshire, so called from the figure of a horse in a galloping posture, cut in the side of a chalky hill, as is supposed in memory of a great victory gained by Alfred over the Danes in the year 871. The scouring the horse is an annual festival, and celebrated by rural games. On the top of the hill is a large Roman intrenchment, called Uffington castle, or Woolston castle. There is likewise another camp in the neighbourhood, with the burial place of the Danish chief, inclosed by stones set on edge, a cromlech, and several barrows.

WHITE *Horses*, cliffs on the south coast of Jamaica; 20 miles E.S.E. of Kingston.

WHITE-*House Bay*, a bay on the west coast of the island of St. Christopher, a little to the north of Guana Point.

WHITE *Inlet*, or *Boca de Ratones*, an inlet on the east coast of East Florida. N. lat. 26°. W. long. 80° 20'.

WHITE *Island*, an island in the South Pacific ocean, near the east coast of New Zealand, north of Cape Run-away. S. lat. 37° 31'. W. long. 182° 36'.—Also, a small island in the Atlantic, near the S.E. coast of Nova Scotia. N. lat. 44° 55'. W. long. 61° 56'.

WHITE *Island*, or *Burnt Island*, a small island in the Arabian Gulf, near the coast of Adel. N. lat. 11° 8'. E. long. 64° 55'.

WHITE, *Isle of*. See *Isle of WIGHT*.

WHITE *Keys River*, a river of Africa, which runs into the Indian sea, S. lat. 30° 35'.

WHITE *Mountains*, mountains of New Hampshire, peculiarly applied to the highest part of a ridge, which extends N.E. and S.W.: the whole circumference at least fifty miles. The height of these mountains above an adjacent meadow is reckoned, from observations made by the Rev. Mr. Cutler, of Ipswich, in 1784, to be about 5500 feet, and the meadow 3500 feet above the level of the sea. The snow and ice cover them nine or ten months in the year, during which time they exhibit that bright appearance from which they are denominated the White Mountains. From this summit, in clear weather, is exhibited a view extending sixty or seventy miles in every direction: although they are more than seventy miles within land, they are seen many leagues off at sea, and appear like an exceedingly bright cloud in the horizon. These immense heights, being copiously replenished with water, afford a variety of cascades. Three of the largest rivers in New England receive a great part of their waters from these mountains. Amanoosuck and Israel rivers, two principal branches of the Connecticut, fall from their western sides. Peabody river, a branch of the Amoriscongen, falls from the north-east side, and almost

the whole of the Saco descends from the southern side. The highest summit of these mountains is in about 44° N. lat.

WHITE Oak Creek, a river of North Carolina, which runs into the Atlantic, N. lat. $34^{\circ} 39'$. W. long. $77^{\circ} 26'$.

WHITE Oak Mountains, mountains in the west part of North Carolina. N. lat. $36^{\circ} 10'$. W. long. $82^{\circ} 30'$.

WHITE Point, a cape on the coast of Cape Breton, near Louisburg.—Also, a cape on the south coast of Jamaica; 20 miles E. of Port Royal.—Also, a cape on the north coast of the island of Cumbava. S. lat. $8^{\circ} 15'$. E. long. $118^{\circ} 51'$.

WHITE River, a river of Louisiana, formerly thought to be a stream of inconsiderable magnitude, but now known to be one of the most considerable in the western country, and likely to become of still greater importance. It rises in the Black Mountains, which separate the waters of the Arkansas from those of the Missouri and Mississippi. Several of its branches interlock with those of the Osage river, the Maramak, and the St. Francis. It is navigable about 1200 miles, without any considerable interruption; 800 of which may be made with barges, and the rest with canoes or smaller boats. Its waters are clear and limpid, its current gentle, and even in the driest season, plentifully supplied from the numerous and excellent springs which are every where found. It also receives many considerable rivers in its course, the largest of which is Black river. The country which it waters is described by those who have traversed it as generally well wooded, and abounding in springs and rivulets: the soil is rich, though hilly; and it is said, that on the borders of this river a country may be chosen, at least 100 miles square, not surpassed by the best parts of Kentucky, and one of the best for settlements in the western world. This river is situated on the S.W. side of the Missouri, and is 300 miles wide at its mouth.

WHITE River, a river of Guadeloupe.—Also, a river of America, which runs into the Connecticut, 4 miles east of Norwich.—Also, a river of Jamaica, which runs into the sea, 4 miles W. of Morant bay.—Also, a river of Indiana, in the county of Koog, which rises about N. lat. $40^{\circ} 45'$, and W. long. $85^{\circ} 5'$, and runs into the Wabash, N. lat. $38^{\circ} 19'$, and W. long. $88^{\circ} 20'$.—Also, a river of America, which runs into lake Michigan, N. lat. $43^{\circ} 40'$. W. long. $85^{\circ} 35'$.—Also, a river of Vermont, which runs into the Connecticut, N. lat. $43^{\circ} 38'$. W. long. $72^{\circ} 16'$.

WHITE Rock, a rocky islet in the East Indian sea, near the south coast of Java.

WHITE Rocks, a range of buildings, accommodated for smelting-houses, about a mile from Swansea, in the county of Glamorgan, situated on the river.

WHITE'S Bay, a bay on the coast of Newfoundland. N. lat. $50^{\circ} 17'$. W. long. $56^{\circ} 15'$.

WHITEBURN, a town of Scotland, in the county of Linlithgow; 21 miles W. of Edinburgh.

WHITECLAY CREEK, a hundred of Delaware, in Newcastle county, with 1701 inhabitants.

WHITEFIELD, GEORGE, in *Biography*, one of the founders of Methodism, (see *METHODISTS*,) was the son of an innkeeper at Gloucester, where he was born in 1714, and where he received the rudiments of literature, so as to be sufficiently qualified for his father's business, for which he was designed. Accordingly he commenced it as drawer at the Bell-inn. At school he is said to have been distinguished by a retentive memory and good elocution. Of his early years, he gives a very unfavourable account, so that there was nothing about him but a fitness to be damned, with occasional gleams of grace that afforded some indication of his future destination. About the age of 18,

he was admitted a servitor at Pembroke college, Oxford, and associated with those young persons whose dispositions and habits resembled his own, and whose conversation and manners contributed to cherish that religious enthusiasm to which he was strongly addicted. As soon as Dr. Benson, bishop of Gloucester, received information concerning the state of his mind and the course of his general conduct, he made him an offer of ordination, when he was about 21 years of age, and he was accordingly ordained a deacon in 1736. Upon his return to Oxford, after preaching his first sermon at Gloucester, he took the degree of bachelor, and diligently employed himself in communicating instruction to the poor and the prisoners. During the two following years, he acquired a great degree of popularity by his public services in London, Bath, Bristol, and other places; collecting large auditories, and interesting the attention of his hearers. His voice was strong and musical, his pronunciation clear and distinct, his imagination was lively, and his feelings were warm; and to these natural powers of eloquence we may add his selection of subjects, which were adapted to rouse the inconsiderate, and to comfort those that were awakened to a sense of their guilt and danger: so that we need not wonder that he should command a numerous audience. Upon receiving information that the province of Georgia was likely to open to him an extensive field of usefulness, he determined to visit it, and in May 1738, arrived at Savannah. Here he met with much greater success than his predecessor Wesley; and in order to supply the defect of education which he was concerned to observe in this province, he resolved to found an orphan-house, and in 1739 returned to England in order to collect money for this purpose. In England few of his clerical brethren were disposed to take much notice of him; nevertheless, his original patron, the bishop of Gloucester, gave him priest's orders: but upon afterwards visiting London, none of the churches into which he obtained admission were large enough to accommodate the crowds of people that assembled to hear him. It was about this time that he commenced his practice of preaching in the open fields, and the first scene of his exhibition in this way seems to have been Kingwood, near Bristol, where he collected thousands, chiefly of colliers, who without doubt derived benefit from his discourses. He also preached at Bristol in the open air, when he was refused access to the pulpits of the churches; and he likewise pursued the same practice in Moorfields and Kennington-common, near London, where, amidst the immense multitude that attended him, some persons occasionally treated him with rudeness, but the greater number were commanded by his peculiar power of address into respectful attention. Having succeeded beyond his expectations in soliciting contributions for his projected orphan-house in Georgia, he returned to America in August 1739; and in the following January laid the foundation of the building at Savannah. He then extended his tour as far as Boston, preaching to immense crowds, and collecting considerable sums for the completion of his design; and upon his return to Savannah he found his orphan family comfortably settled in their house; and in January 1741, he embarked for England. His absence had occasioned a declension among his followers; some other circumstances, besides the intermission of his personal labours amongst them, might probably have contributed to produce this effect. Whilst he was in America he had written, as he himself acknowledges, "two well-meant but injudicious letters against England's two great favourites, the Whole Duty of Man, and archbishop Tillotson, who, I said, knew no more of religion than Mahomet." His society had suffered from the influence of the Moravians. Mr. Wesley

had preached and printed in favour of perfection and universal redemption, and against the doctrine of election. He had written a reply, but he acknowledges that he had used expressions that were too strong in reference to absolute reprobation, which had offended numbers of his spiritual children. His worldly circumstances were embarrassed, and he owed 1000*l.* for the orphan-house, and some of his bills were returned. He had some enemies who circulated reflections on his integrity in the contract of this business; but they were never justified, and his state of secular affairs at his death affords a strong presumption that they were groundless. Dr. Franklin, who lived upon the spot, bears testimony to his honesty. At this time, a separation had taken place between him and Wesley, and this had occasioned a decrease of his auditors. However, his zeal and perseverance overcame these difficulties. In order to counteract Wesley's popularity, he built a shed near his chapel in Moorfields, which he called the Tabernacle; and in process of time this rose from a mean beginning to be a spacious edifice; and he also renewed his field-preaching. At this time, he paid his first visit to Scotland; and though he was a clergyman of the church of England, which excited some prejudice against him, he was invited into the churches, and preached to large congregations, and made collections for his orphans. On his return by Wales, he married a Mrs. James, a widow lady of Abergavenny. His zeal for doing good, and for making profelytes, induced him, in the spring of 1742, to engage in a contest with the idle people who had booths in Moorfields, and where they frequented for their amusement on holidays. On Whitmonday he collected a party of his attendants, and resorted to the spot with a view of conducting a religious service. Although he was much disturbed in this effusion of his piety and zeal, the result, as he says, was so much in his favour, that he received 1000 notes from persons under conviction; and soon after more than 300 were admitted into the society in one day. In 1748 he returned from a third voyage to America; and then commenced his acquaintance with the countess of Huntingdon, who appointed him her chaplain, and excited the curiosity of some persons of rank to hear him: among these were the earl of Chesterfield and lord Bolingbroke. About this period, it is said, his sentiments became more rational; for on his third visit to Scotland, it was announced to a synod assembled at Glasgow to investigate certain charges against his opinions, that with regard to certain points which were considered as objectionable, his sentiments had been altered for upwards of two years; and that he now seldom preached a sermon without guarding his hearers against impressions, and admonishing them that a holy life is the best evidence of a state of grace. From this time, he was fully employed by a visit to Ireland, two more voyages to America, and his English circuits, till the year 1756, when his chapel in Tottenham-court-road was erected. His labours were incessant for many years; but at length, on a seventh visit to America, he was seized with an athmatic complaint at Newburyport, New England, which terminated his life in September 1770, near the completion of his fifty-sixth year.

With regard to his general character, we shall close this article with the reflections of a judicious and candid biographer. "That he had much enthusiasm and fanaticism in his composition is sufficiently evident from his own journal and letters; but whether these were accompanied, as they not unfrequently are, with craft and artifice, is a disputable point. There are, in his narratives, obvious marks of a disposition to represent himself as under the special protection of Providence, and to magnify trifling incidents into little less than miracles in his favour; and much of what is com-

monly called cant is apparent in his confessions and humiliations. Yet that he was a hypocrite acting a part will scarcely be believed by any one who looks at his course of life during 34 years. He has been charged with dishonesty and immorality; yet as it is certain that he obtained the esteem of many persons of worth, it may be concluded that such accusations were destitute of proof. His intellectual qualities were well suited to the task he undertook; and if in the pulpit he occasionally intermixed buffoonery with his vehemence, the latter was not less effectual on that account. His learning and literary talents were mean, and he is a writer only for his own sect." He published, at intervals, sermons, tracts, and letters, which, after his death, were collected in six vols. 8vo. *Middleton's Biog. Evangel. Mosh. Eccl. Hist. Gen. Biog.*

WHITEFIELD, in *Geography*, a town of America, in the district of Maine, and county of Lincoln, having 995 inhabitants.—Also, a town of New Hampshire, in the county of Cowes, having 51 inhabitants.—Also, a town of North Carolina; 40 miles W. of Newbern.

WHITEFIELD, or *Wheatfield*, a township of Pennsylvania; 156 miles W. of Philadelphia.

WHITEHALL, formerly called Skenesborough, a post-township of Washington county, in the state of New York, at the head of lake Champlain, about 65 miles N.E. from Albany: in medial length about 10 miles from N. to S., and 7 wide; first erected in 1788, with its present limits. The soil is a stiff clay, and adapted to grass. Wood-creek and Pawlet river unite in this town, and afford facility to navigation and trade, as well as mill-seats. Marble, limestone, and iron-ore, and also a mineral spring, are found in this township. It has 1 Congregational, 1 Presbyterian, 1 Baptist, and 1 Methodist congregation, and a competent number of common schools; 2 grist-mills, 2 saw-mills, a fulling-mill, and carding-machine.—Also, an incorporated post-village at the N. end, with considerable trade, situated principally on the W. bank of Wood-creek, at its entrance into lake Champlain; 71 miles N.E. from Albany. About a quarter of a mile from the village is a handsome Presbyterian church, founded by the donation of John Williams, esq. of Salem, who endowed it with a parsonage of 60 acres of land. The whole population, by the census of 1810, was 2119, with 178 electors.—Also, a township of Pennsylvania, in Northampton county, with 2551 inhabitants; 61 miles N. of Philadelphia.

WHITEHAVEN, a sea-port and market-town in Allerdale ward, in the county of Cumberland, England, is situated between two hills at the northern extremity of a narrow vale, at the distance of 40 miles S.W. from Carlisle, and 305 miles N.W. from London. The rise, progress, and increasing importance of this now rich and flourishing town, strikingly display the effects of trade, industry, and enterprise. From an obscure hamlet, it has advanced, within less than two centuries, to considerable magnitude and commercial importance; and, both in extent and population, by far exceeds the capital of the county. In the year 1566, it consisted only of six fishermen's cabins; in 1633, of nine or ten thatched cottages; but in 1693, its buildings were sufficiently numerous for 222 inhabitants, and have been progressively increasing; till, in the year 1811, the population was returned to parliament as 10,106, occupying 1940 houses. The increase of shipping has been proportionate: in 1685, the whole number of vessels belonging to this port was 46, carrying 1871 tons; they have since gradually increased to 230; the quantity of tonnage is nearly 74,000 tons. The honour of raising this town to its present importance must be attributed to the Lowther family.

family. Sir John Lowther, about the beginning of the reign of Charles I., purchased the lands of the dissolved monastery of St. Bees for his second son, sir Christopher, who, as coals about that period came into general use, conceived the idea of improving his possessions by opening some collieries. No effectual progress was, however, made till after the Restoration, when another sir John Lowther, who had succeeded to the estate, formed a plan for working the mines on a very extensive scale. To obviate all opposition to his operations, he procured a gift of all the ungranted lands within the district, and also of the whole sea-coast for two miles northward, between high and low water mark. He then directed his attention to the port, which was small and inconvenient; and, by his judicious schemes, laid the foundation of the present haven. Subsequent improvements have been made, particularly during the reign of George II., when an act was passed to perfect and keep it in repair, by a tonnage on shipping. The mines are said to be the deepest in England, and extend a considerable way under the sea: one has been carried 1000 yards out from the shore, at the depth of 112 fathoms under the water. Most of the coal exported from this haven is conveyed to Ireland; the quantity raised annually, on the average, is about 90,000 chaldrons. (See COAL.) The creek on which Whitehaven is built is so deeply seated, that the adjacent lands overlook it on every side. The approach from the north is singular, as the heights are so much above the town, that only the roofs of the houses can be seen till near the entrance, which, on this point, is through an archway of red free-stone. The town itself is one of the most respectable in all the northern counties; the streets being regular and spacious, and crossing each other at right angles; the houses in general are well built, and even the tradesmen's shops exhibit a degree of elegance. Here are three chapels, plain convenient structures: they were all erected by subscription of the inhabitants, aided by the benevolence of the Lowther family. St. Nicholas's chapel was built in 1693; Trinity, in 1715; St. James's, in 1752. The latter is neatly fitted up; the roof and galleries are supported by ranges of pillars. Besides the established chapels, here are three meeting-houses for Methodists, two for Presbyterians, and one for each of the following sects, Anabaptists, Roman Catholics, Glassites, and Sandemanians. The principal manufactures are those of cordage and sail-cloth; the latter was only established in 1786, but already gives employment to several hundred workmen, though much of the business is executed by machinery of great power. A fair is held annually, and there are three weekly markets. The castle, as it is called, adjoining the east side of the town, one of the seats of the earl of Lonsdale, is a large quadrangular building, chiefly erected by the late earl, and containing some good paintings.

St. Bees, in which parish Whitehaven is situated, derives its origin from a religious house founded here by Bega, an Irish saint, about the year 650. On her death, a church was erected to her honour; but both these establishments having been destroyed by the Danes, they were replaced, in the reign of Henry I., by a new foundation for Benedictine monks. The church built at this period had the form of a cross, and great part of it yet remains. The east end is unroofed, and in ruins; the nave is fitted up as the parish church; and the cross-aisle is used as a burial-place. The whole is of a red free-stone. In this village a free-school was founded by a bequest of archbishop Grindall, in the year 1587, under a charter of queen Elizabeth. The endowments were increased by James I., and have been since further augmented by various benefactions.—*Beauties of England and Wales*, vol. iii. Cumberland, by J. Britton

and E. W. Brayley, 1802. *Magna Britannia*, Cumberland, by Messrs. Lysons, 4to. 1816.

WHITEHEAD, WILLIAM, in *Biography*, an English poet, was born at Cambridge in 1714-5, educated at Winchester school, where from his talent in writing verse he acquired the notice of Pope; and upon his return to Cambridge, obtained a scholarship of Clare-hall. As a poet, Whitehead's highest ambition was to resemble the manner of Pope; and of his proficiency he gave a specimen in his "Epistle on the Danger of writing Verse," 1741. In the following year he was elected fellow of Clare-hall, and pursued his studies with a view to the church; but his poetical talents produced a change in his circumstances and in his purpose. Being recommended to the earl of Jersey as a proper tutor for his eldest son, he removed in 1745 to the earl's house in London, where his treatment was in the highest degree liberal. Having leisure for indulging his taste for literary pursuits, he turned his attention to dramatic composition, and produced a tragedy, entitled "The Roman Father," which was exhibited with applause upon the stage in Drury-lane in 1750. In 1754 he published another, the title of which was "Creusa," which was also favourably received. With the profits arising from these two performances he very honourably discharged the debts of his father, who had died insolvent. In this year he accompanied his pupil, viscount Villiers, and viscount Nuneham, son of earl Harcourt, on their travels, which continued more than two years; and on his return he published an "Ode to the Tiber," and six elegiac epistles, which were much applauded. Lady Jersey, during his absence, had procured for him the appointment of secretary and register to the order of the Bath; and in 1757, on the death of Cibber, he succeeded to the laureat, which he rendered respectable; though in the discharge of the customary duties of the office, he did not escape abuse, and especially that of Churchill, whose popular satire almost overwhelmed the reputation of the laureat. Lady Jersey, in consideration of his services as governor to her son, invited him to take up his residence in her house, where he passed fourteen years, frequently visiting lord Harcourt, much respected by his noble hosts and his former pupils. He still amused himself by presenting to the public occasional productions, one of which was a comedy of the moral or sentimental class, entitled "The School for Lovers." After passing through life tranquilly and pleasantly, and maintaining an estimable character, he died suddenly, April 1785, in his 70th year. Of his works two volumes were published by himself, and to these a third was added by Mr. Mason, who prefixed memoirs of his life and writings, to which we refer. *Gen. Biog.*

WHITEHEAD, GEORGE, an eminent person among the Quakers, was born in 1636 at Sunbigg, in Westmoreland. Attaching himself early in life to this society, and engaging in the propagation of its doctrine, he partook of the sufferings which, in that age, were the ordinary lot of its active members; and was once, simply for having preached at Nayland, in Suffolk, severely whipped by order of two justices as a vagabond; a proceeding which served, as might have been expected, to increase the disposition of the people to hear him. Soon after the Restoration of the monarchy, the Quakers were made the express subjects of a law, the precursor of others of like nature, which imposed on their profession and worship penalties extending to banishment. In the progress of the bill through the house of commons, Whitehead, with three other Quakers, was admitted to the bar of the house, and heard in defence of the society. They pleaded its cause with the freedom of conscious innocence,

cence, and the meekness of men prepared to suffer, but pleaded in vain:—the bill passed, and two out of the four, who had thus advocated the rights of conscience, presently fell victims to the force by which conscience was deliberately oppressed, dying in a crowded unhealthy prison, to which they were dragged from their peaceable religious meetings. Whitehead, who was imprisoned with them, survived to be liberated.

In the year 1672, when Charles II. issued his declaration for suspending the penal statutes against non-conformists, Whitehead solicited and obtained an order under the great seal for the discharge of about four hundred Quakers, many of whom had been for years under close confinement. He records, with expressions of satisfaction, the circumstance that some other dissenters also partook at this time of the benefit of his exertions. On several other occasions he was concerned in applications on the Quakers' behalf to Charles II. and James II. And after the Revolution, when the Toleration Bill was before parliament, he was particularly serviceable to his friends in that matter; as likewise in taking a part in those representations, which procured the acceptance of their affirmation in lieu of an oath. A profession of faith being proposed for insertion in the above act, in terms which to the Quakers would not have been quite satisfactory, Whitehead and his coadjutors proposed the following, as their own belief on the points to which it relates, and which was adopted as a test for the society accordingly, *viz.* "I profess faith in God the Father, and in Jesus Christ his Eternal Son the true God, and in the Holy Spirit, one God, blessed for evermore; and do acknowledge the holy scriptures of the Old and New Testament to be given by divine inspiration."

Whitehead lived the greater part of his time in or near London, which accounts for his being one of those Quakers usually concerned in applications to the government. He was well esteemed by his brethren, whom he continued to edify by his ministry and example to the end, dying, after a short confinement, by infirmity, at the age of 86. Besides several writings chiefly controversial, he left some memoirs of his life, which were printed in one volume, 8vo. in 1725.

WHITEHEAD, in *Geography*, an island in the Atlantic, near the coast of Maine. N. lat. $44^{\circ} 43'$. W. long. $67^{\circ} 40'$.—Also, a cape of Ireland, at the north-east of the bay of Carrickfergus, in the county of Antrim.

WHITEHORN, a royal borough and market-town in the district of Machers, and shire of Wigtown, Scotland, is situated on the western side of the bay of Wigtown, at the distance of 116 miles S.S.W. from Edinburgh. It is a place of great antiquity, having been the Roman station *Leucophibia*, or *Candida-Casa* of Bede, and the capital of the Novantes, who possessed all Galloway beyond the river Dee; and it was so early the seat of religion, that, according to Pinkerton, the bishopric of Galloway, or Whitehorn, is the oldest in Scotland. The cathedral, of which there are now scarcely any remains, was founded in the fourth century by St. Ninian. A priory of the Premonstratensian order was also early founded here, and richly endowed by Fergus, lord of Galloway. The borough now consists chiefly of one large well-built street, extending from north to south, intersected by several smaller. A rivulet, over which is a neat bridge, runs across the main street. Near the centre of the town is a respectable hall for public meetings, adorned with turrets and a spire, and furnished with a set of bells. Whitehorn is governed by a provost, two bailties, and fifteen counsellors; and unites with the boroughs of New Galloway, Wigtown, and Stranraer, in

sending a representative to the imperial parliament. A weekly market is well supplied. The tanning of leather has been carried on several years to a considerable extent, and some cotton manufactures have been commenced. The parish of Whitehorn extends eight miles in length and four in breadth, and occupies that extremity of the peninsula of the shire of Wigtown which is formed by the bays of Wigtown and Luce. The soil is in general fertile, and the farms well cultivated. Here are many extensive plantations in a flourishing condition; considerable quarries of variegated marble and strong slate; and promising appearances of lead and copper mines, but none have as yet been worked. The extent of sea-coast is about nine miles. The isle of Whitehorn, included in the parish, has a safe harbour, and a village containing 350 inhabitants. According to the return of the year 1811, the population of the whole parish was 1935.—*Beauties of Scotland*, vol. ii. Wigtownshire. *Carlisle's Topographical Dictionary of Scotland*, vol. ii. 1813.

WHITEHORN, a small island of Scotland, near the south-east coast of the county of Wigtown. N. lat. $54^{\circ} 46'$. W. long. $4^{\circ} 27'$.

WHITEHURST, JOHN, in *Biography*, was born at Congleton, in Cheshire, in 1713, and brought up to the trade of his father, who was a watch-maker. At the age of 21 years he visited Dublin, in order to acquaint himself with the construction of a curious clock; but being disappointed, he engaged in business for himself at Derby, about two or three years after his return, where he distinguished himself by a variety of ingenious pieces of mechanism; and he thus established a reputation, which caused him to be consulted by all persons who wished to avail themselves of superior skill in mechanics, pneumatics, and hydraulics. In 1775 he was appointed, without any solicitation on his own part, stamper of the money weights; which office required his removal to London, where he spent the remainder of his days, and where his house was the resort of scientific men of various descriptions. In 1778 he published his "Inquiry into the original State and Formation of the Earth," of which an enlarged and improved edition appeared in 1786, and a third in 1792. In May 1779 he was elected a fellow of the Royal Society. In 1783 he visited Ireland, to examine the Giant's Causeway, and the northern parts of the island; and the result of his inquiries was annexed to his work above-mentioned. In the course of his journey he erected an engine for raising water from a well to the summit of a hill, in a bleaching-ground at Tullidoi, in the county of Tyrone. It is worked by a current of water, and is of very curious construction. In 1787 he published "An Attempt towards obtaining invariable Measures of Length, Capacity, and Weight, from the Mensuration of Time." (See STANDARD.) Mr. Whitehurst, having been for some time subject to the gout, was at length carried off by a paroxysm of it in the stomach, in February 1788, in the 75th year of his age, at his house in Bolt-court, Fleet-street. As a man of science, he was much respected by all who knew him; but he was still more estimable on account of his moral qualities. In his dress he was plain, temperate in his diet, and in his general intercourse with mankind easy of access, benevolent in his disposition, and obliging in his manners. His papers on Chimneys, Ventilation, and Garden-stoves, were collected and published in 1794 by Dr. Willan. His papers in the *Philosophical Transactions*, printed afterwards in the collection of his works in 1792, were the following: *viz.* "Thermometrical Observations at Derby," in vol. lvii.; "An Account of a Machine for raising Water at Oulton in Cheshire," vol. lxxv.; and "Experiments

periments on ignited Substances," vol. lxvi. Hutton's Math. Dict.

WHITEKIRK, in *Geography*, a parish and village of Scotland, in the county of Haddington; 4 miles S.E. of North Berwick.

WHITELAND, WEST. See *WEST Whiteland*.

WHITELICK, a town of the state of Kentucky; 13 miles S. of Stamford.

WHITELock, BULSTRODE, in *Biography*, a lawyer and statesman, was born in London in the year 1605, and finished his education as a gentleman-commoner of St. John's college, Oxford. Being destined for the profession of the law, he pursued the study of it under the direction of his father, Sir James Whitelock, who was one of the justices of the King's Bench. As he had a taste for the fine arts, he was nominated as one of the chief managers of the royal masque presented by the inns of court to Charles I. and his queen in 1633, of which he has given a florid description. He became soon distinguished in his profession at the bar, and was frequently consulted by Hampden, when he was under prosecution for resisting the imposition of ship-money. In 1640 he was elected as a representative for Marlow in the Long parliament; and though his principles were favourable to the measures which then engaged the public attention, he concurred with Selden and others in deprecating a resort to arms; but when the house had determined for war, he accepted the post of deputy-lieutenant for the counties of Oxford and Buckingham, and appeared at the head of a gallant company of horse raised among his neighbours. Nevertheless he was always averse from a civil contest; and in January 1642-3, he was one of the commissioners appointed to treat of peace with the king at Oxford; and in 1644 he was one of those who presented to the king propositions of peace agreed upon in parliament; and the king's answer was, at his majesty's request, drawn up by him and Holles, for which they were accused of high treason by parliament, but extricated themselves with honour. As a member of the assembly at Westminster for settling the form of church government, he avowed himself in opposition to the divine right of presbytery. He also opposed the power of excommunication assumed by the Presbyterians; being always, like Selden, an enemy to violent exertions of church power by any party; and he was an invariable advocate of legal rights, and an opposer of arbitrary power, assumed or exercised in either house of parliament. When he became suspected by the parliamentary leaders, he joined the army-party, and opposed the measure of disbanding the troops, which was proposed by some of his former associates. When it was determined to bring the king to trial, he was nominated as one of the committee for drawing up the charge; but this was a business in which he did not choose to engage. However, he had no objection against taking an active part under the new government, and he was nominated in February 1648-9 one of the council of state. In some other instances he incurred the charge of inconsistency, as he complied with measures which he did not approve. To Cromwell he was so agreeable, that he was one of the four members of parliament appointed to meet him after his famous victory at Worcester in 1651. Whitelock avowed himself steadily attached to monarchy, as a part of the state which could not be dispensed with, and as interwoven with the laws of the country; and he therefore suggested, that the late king's eldest or second son should be sent for, and enter into terms for securing the liberties of the nation. Upon the dissolution of parliament by Cromwell, though he had previously resisted the attempts of the army to govern without the parliament, he obsequiously performed the

functions of his office under the new establishment. The usurper, however, regarded him with distrust, and would not admit him into his first or little parliament. His commission of the seals was superseded by the suppression of the court of chancery; and he was therefore glad to be occupied in a station which would not require his interference in party contests, which was that of ambassador from England to queen Christina of Sweden. Upon his departure, Cromwell assumed the title and authority of lord protector, and issued his instrument of government, which Mr. Whitelock had concurred in preparing, and which was afterwards found by Cromwell incompatible with his usurpation. Having concluded an advantageous treaty with queen Christina, who received him in November 1653 with distinction, he returned to his own country, and resumed the office of commissioner of the great seal, upon the restoration of the court of chancery; and he was returned as a representative for three counties in Cromwell's second parliament. Upon Cromwell's regulation and limitation of the court of chancery, he again resigned the custody of the seal; and as some compensation for his loss, he was appointed a commissioner of the treasury. He was free and faithful in giving salutary advice to the Protector, and nevertheless retained his confidence. Declining the office of ambassador to Sweden, which was offered him, he acted as one of the commissioners to treat with the Swedish ambassador in England. He was returned for Buckinghamshire in Cromwell's third parliament, and officiated for some time as speaker. Although he would not present to parliament the "Humble Petition and Advice," which was intended to empower Cromwell to assume a higher title than that of Protector, he was chairman of the committee for conferring with him about it; and he concurred in the request that he would adopt the royal title. Whitelock contracted so decidedly in Cromwell's interest, that he was one of those who were called by him to the upper house; but he declined being governor of Dunkirk, and also the honour of being created a viscount. During the short protectorate of Richard, Whitelock acted as one of the keepers of the great seal; and when the army set up a republican government, he was nominated one of the council of state; and as its president, he joined in all the measures that were adopted for upholding the tottering frame of government, on the principle that if no legal authority was acknowledged, the sword alone would probably govern. When Monk proposed to restore the remains of the Long parliament, Whitelock took a commission from the committee of safety for raising a regiment of horse, and urged Lambert to march against that leader. But the design failing, and the parliament meeting, he just appeared in pursuance of the speaker's summons; and as he had reason for suspecting a design to apprehend him, he returned to a friend's house in the country, and sent the great seal by his wife to the speaker;—and thus terminated his public life. Upon the Restoration, he had the good fortune to escape a bill of pains and penalties in the house of commons, only by the negative of a small majority. After having passed fifteen years in retirement, chiefly at Chilton-park in Wiltshire, he there died in January 1676; leaving a numerous family, after having been twice married.

Possessed of considerable abilities, and of distinguished talents for business, he would have claimed a more general and cordial respect, if he had not been a temporizer in his public conduct. His principles of government appear, however, to have been good, and in his temper he was averse from every kind of violence and injustice. He was a well-wisher to the law and constitution, and supported them as far as it was consistent with his interest and safety. In all private

private concerns he maintained an estimable character for probity and honour. After his death an anonymous editor, in 1682, published his "Memorials of the English Affairs; or, an historical Account of what passed from the Beginning of the Reign of King Charles I. to King Charles II. his happy Restoration," fol.; an improved edition of which appeared in 1732. From his MSS. were published in 1709, "Memorials of the English Affairs from the supposed Expedition of Brute to this Island, to the End of the Reign of King James I.," a chronological epitome of history for his own use. In 1766 Dr. Charles Morton, secretary to the Royal Society, published "Whitelock's Notes upon the King's Writ for choosing Members of Parliament, 13 Car. II. being Disquisitions on the Government of England by King, Lords, and Commons," 2 vols. 4to. The same editor also published in 1772, "A Journal of the Swedish Embassy in the Years 1653 and 1654, from the Commonwealth of England, Scotland, and Ireland; written by the Ambassador the Lord Commissioner Whitelock; with an Appendix of original Papers," 2 vols. 4to. Biog. Brit. Gen. Biog.

The commissioner, amid all his grave affairs, found leisure to cultivate music, of which he was very fond; and seems to have interested himself in all the remarkable performances of his time. During the happy days of Charles I., masques were so frequent at court and elsewhere, that in 1633 no less than five masques were performed at different places before the king and queen. See MASQUE.

A very circumstantial account of one of these, "The Triumphs of Peace," has been left to his family by the commissioner himself, which was in the possession of the late Dr. Morton of the British Museum. The musical part of this performance seems to have been wholly assigned by the benchers at the Temple to commissioner Whitelock. For in his narrative he says, "I made choice of Mr. Symon Ives, an honest and able musician, of excellent skill in the art, and of Mr. Lawes, to compose all the aiers, lessons, and songs for the masque, and to be masters of all the musick under me." See IVES, and LAWES, WILLIAM.

The commissioner, besides being a performer, was a bit of a composer; as he says with great triumph at the latter end of his narrative: "I was so conversant with the musitians, and so willing to gaine their favour, especially at this time, that I composed an aier myselfe, with the assistance of Mr. Ives, and called it 'Whitelocke's Coranto;' which being cried up, was first played publicly, by the Blackefryar's musicke, who were then esteemed the best of common musitians in London. Whenever I came to that house (as I did sometimes in those dayes), though not often, to see a play, the musitians would presently play 'Whitelocke's Coranto;' and it was so often called for, that they would have it played twice or thrice in an afternoon. The queen hearing it, would not be persuaded that it was made by an Englishman, because she said it was fuller of life and spirit than the English aiers use to be; butt she honoured the 'Coranto' and the maker of it with her majestyes royall commendation. It grew to that request, that all the common musitians in this towne, and all over the kingdome, gott the composition of it, and played it publicly in all places, for above thirtie years after."

Among other moral reflections, addressed to his family, on such vanities as he had been describing, lord commissioner Whitelock adds: "Yet I am farre from discommending the knowledge of this art (music), and exercise of this recreation for a diversion, and so as you spend not too much of your time in it, that I advise you in this as in other accomplishments, that you endeavour to gett to some per-

fection, as I did, and it will be the more ornament and delight to you."

The lord commissioner inserts his aier, in order to preserve it for the use of his family, if any of them should delight in it. This "Coranto" may be seen in Burney's Hist. Mus. vol. iii.; and the whole narrative of the masque, entitled "The Triumph of Peace," from "Whitelock's Labours remembered in the Annales of his Life, written for the Use of his Children," MS.

WHITEMARSH, in *Geography*, a township of Pennsylvania, in the county of Montgomery, with 1328 inhabitants; 15 miles N.W. of Philadelphia.

WHITEN HEAD, a cape on the north coast of Scotland. N. lat. 58° 37'. W. long. 4° 22'.

WHITENESS, a town of the island of Shetland; 6 miles N.W. of Lerwick.

WHITENING of Bones, for a skeleton. See BONE.

WHITENING of Cloth. See BLEACHING.

WHITENING of Hair. See HAIR.

WHITENING of Wax. See WAX.

WHITEPAINE, in *Geography*, a town of Pennsylvania, in the county of Montgomery, with 955 inhabitants; 20 miles N.W. of Philadelphia.

WHITE-PLAINS, a post-township and half-shire town of West Chester county, in New York; 30 miles from New York, and 140 S. of Albany. The whole area of this town is about 8½ square miles; and its population, in 1810, was 693, with 68 electors, and 109 taxable inhabitants. The village of White-plains is pleasantly situated on a fine plain, three-quarters of a mile E. of Bronx creek, and contains a court-house, prison, and a handsome collection of houses. The American troops were defeated in this place, by the British under general Howe, in the year 1776.

WHITESAND BAY, a bay on the W. coast of England, in the county of Cornwall, a little to the N. of the Land's End. N. lat. 50° 6'. W. long. 5° 34'.—Also, a bay on the W. coast of Wales; 1 mile N.W. of St. David's.

WHITESEA, a large gulf of the North Frozen sea, on the N. coast of Russia, bounded on the N.E. and S. by the government of Olonetz, in the vicinity of Archangel, extending from N. to S. within the land, from 69° to 63° of N. lat., and containing a number of small islands.

WHITETOWN, the principal town and half shire of the county of Oneida, in the state of New York, situated on the Mohawk river, 95 miles N.W. of Albany; including Utica, and having three post-offices. Its form is irregular, and area about 40 square miles. In January, 1785, Mr. Hugh White, from Connecticut, with a young family, became the first settler. In 1788 the town of German Flats was divided, and a new town erected, and named Whitetown, in honour of Mr. White. In 1798 the county of Oneida was established, by a subdivision of Herkimer, and Whitetown included within this county. By subsequent divisions, Whitetown was reduced to a medial measure of 9 miles by 8. It is situated immediately on the great thoroughfare between Albany and the Western lakes; between Canada and the principal commercial sea-ports of the American states on the Atlantic ocean. This town contains three large post-villages, Utica incorporated, Whitesborough, and New Hartford. Whitetown, including these villages, is unrivalled, in the United States, with regard to wealth, population, trade, and improvements, among inland towns of such recent settlement; and none in this state, of the same area, affords so great a population. It has seven principal churches; one Episcopal, three Presbyterian, two Baptist, in one of which the service is performed

formed in the Welsh language, and one of Welsh Independents, besides some smaller houses dedicated to the same purpose. Here are three grammar-schools, one in each village, and many common schools. It has also a cotton manufactory. This town has been gradually enlarged and embellished. Its population, by the census of 1810, is 4912, with 533 senatorial electors.

WHITEWATER, a township of Ohio, in Henieton county, with 910 inhabitants.—Also, a river of Scotland, which runs into the Esk, in the county of Forfar.

WHITGIFT, JOHN, in *Biography*, an English prelate, was born at Great Grimby, Lincolnshire, in 1530, and in 1548 entered at Queen's college, Cambridge, from which he removed to Pembroke-hall, where he enjoyed the tuition of John Bradford, afterwards one of the Protestant martyrs. In 1555 he became a fellow of Peter-house, and in 1557 commenced M.A. Upon the visitation of the university by cardinal Pole, about this time, for the purpose of purging it of reputed heretics, Whitgift dreaded the search; but by favour of the vice-chancellor escaped, and remained in the university. Upon the accession of queen Elizabeth, he entered into orders in 1560, and obtained preferment from Dr. Cox, bishop of Ely. In 1563 he was appointed Margaret professor of divinity, and chaplain to the queen in 1565. Continuing in the university, and maintaining the character of a good preacher and vigorous disciplinarian, his salary as professor was advanced, and a licence was granted him to preach in any part of the realm. In 1567 he was made master of Pembroke-hall, and soon after regius professor of divinity. He next became master of Trinity college, and graduated D.D.; and on his appointment to keep the commencement-act, he chose for his thesis "The Pope is the Antichrist." In 1570 he formed a body of statutes for the university; in consequence of which the heads of houses gained new powers, by the exercise of which he deprived Cartwright, an eminent Calvinistic divine, of his Margaret professorship. In 1571 he was vice-chancellor of the university, in the exercise of which office he manifested so much zeal for the established church, that the queen conferred upon him the deanery of Lincoln, besides other dignities and honours. He also expelled Cartwright from his fellowship, and carried on a controversy with that divine and other Puritans in general. In 1577 he was advanced to the see of Worcester, and the office of vice-president of the council for the marches of Wales. Upon his advancement to the prelate, he resigned his mastership of Trinity college, and devoted himself to the duties of his new office, taking care to improve its revenues; and in the exercise of a power, which he obtained from the crown by the interest of lord Burleigh, to bestow the prebends of his church on his own friends according to his own selection. His zeal, however, against popish recusants, which was thus recompensed, and which he exercised without due discrimination in the execution of his office as vice-president of Wales, involved him in disputes with the other judges, and offended the president, sir Henry Sydney, so that on his return from Ireland, where he was lord-deputy, he discharged Whitgift from his post. As he occupied new stations, his reputation as a man of business increased; and in 1582 he was nominated by the archbishop of Canterbury, Grindal, chief commissioner for settling disputes in the dioceses of Lichfield and of Hereford. Grindal's remissness in executing the laws against the non-conforming clergy displeased the queen, and caused her to suspend him from his functions; and on his death in 1583, Whitgift, who had secured her favour by his zeal for the church and hostility to the Puritans, was appointed to succeed him. He did not disappoint her expectations; but

engaged her to issue a new ecclesiastical commission, more arbitrary and possessing more extensive authority than any former one. Its jurisdiction extended over the whole kingdom, and comprehended all orders of men; and as Hume describes it, "every circumstance of its authority, and all its methods of proceeding, were contrary to the clearest principles of law and natural equity." "In a word," says he, "this court was a real *inquisition*, attended with all the iniquities, as well as cruelties, inseparable from that tribunal." The measures of Whitgift were in unison with the constitution and spirit of this commission; and the council itself interposed to moderate them. In reply to the remonstrance of the council in favour of some ministers of Ely, who had been suspended for refusing to answer interrogatories, he said, "Rather than grant them liberty to preach, he would choose to die, or live in prison all the days of his life." To the queen he recommended "suppressing" the discipline proposed by the Puritans, "rather than confuting it by writing;" and he advised that a restraint should be laid upon the liberty of the press at Cambridge. It is no wonder that by such conduct he should become the object of great aversion to the puritanical party. Accordingly he was very acrimoniously attacked in a pamphlet, entitled "Martyn Marprelate," in which he was compared to the most ambitious and tyrannical churchmen of former times. Whitgift, however, blended with the violence of his temper some degree of kindness and good humour. This was manifested in his conduct towards Cartwright. In his charities he was munificent, and in his mode of living hospitable, as well as splendid and ostentatious. In 1595 he laid the foundation of a hospital at Croydon, on which very large sums were expended. He maintained several students at the university, and entertained for many years at his palace several refugee divines, that had been recommended to him by Beza and others. His house, it is said, was as much an academy for martial exercises as a school for letters. "On his progresses he was attended by a numerous and splendid train; and at his first journey into Kent he rode into Dover with one hundred of his own servants in livery, of whom forty were gentlemen wearing gold chains. On festival days he was served with great solemnity, sometimes on the knee; and public worship in his chapels was performed with every circumstance of religious pomp. This external grandeur exalted the church of England in the eyes of foreigners, who had been led to imagine that the Reformation in this country had degraded the ecclesiastical establishment as much as it had done in some others."

Upon the accession of king James, Whitgift felt some alarm under the apprehension of some changes in the liturgy; and it has been supposed that his agitated state of mind concurred with the debility of age, and the operation of some other causes, in producing the paralytic attack which terminated his life in February 1603-4. A monument was erected to his memory at Croydon, where he was interred. Whitgift was neither a man of learning, the Latin language bounding his classical literature, nor a profound theologian. He was principally distinguished by his vigour and activity as a man of business. As a preacher he was popular; and this talent in which he excelled laid the foundation of his advancement. *Biog. Brit. Hume's Hist. Gen. Biog.*

WHITING, in *Ichthyology*, the English name of a common fish of the *afellus* kind, commonly distinguished by the writers in ichthyology by the name of *afellus mollis*, though by some called *afellus albus* and *merlangus*.

The whiting, or gadus merlangus of Linnæus, is a fish of an elegant form; the upper jaw is the longest; the eyes are large, the nose sharp, and the teeth of the upper jaw long,

long, appearing above the lower when closed: the first dorsal fin has fifteen rays, the second eighteen, and the last twenty. The colour of the head and back is a pale brown; the lateral line white and crooked; the belly and sides silvery; the last streaked lengthways with yellow.

Whitings appear in large shoals in our seas in the spring, keeping at the distance of about half a mile to that of three miles from the shore. They are the most delicate and wholesome of any of the genus; and seldom grow to more than ten or twelve inches in length. Pennant.

No whiting is to be taken in the Thames or Medway of less size than six inches from the eye to the end of the tail, or at any time except from Michaelmas-day to Ember week. (30 Geo. II. cap. 21.) Nor under six inches any where else. 1 Geo. I. stat. 2. cap. 18.

WHITING-POLLACK. See *GADUS Pollachius*, and POLLACK.

WHITING-POUT. See POUTING, and *GADUS Barbatus*.

WHITING, in *Geography*, a township of Vermont, in the county of Addison, with 565 inhabitants; 25 miles N. of Rutland.

WHITING Bay, a small bay of the county of Waterford, Ireland, a little E. of Youghal bay.

WHITLEY, a township of Pennsylvania, in Greene county, with 1264 inhabitants.

WHITLOW, in *Surgery*, called also by surgeons *paronychia*, *panaritium*, *onychia*, &c. is an inflammation affecting one or more of the phalanges of the fingers, and generally terminating in an abscess. These are the parts which are the usual situation of the complaint; but sometimes a disease, which is precisely similar, makes its attack upon the toes. It is likewise to be understood, that in severe cases, the disorder extends itself to many other parts besides the finger, the matter making its way upward higher than the wrist. Thus, as Callisen justly observes, the skin, cellular substance, sheath of the flexor tendons, and less commonly that of the extensors, the tendons themselves, the annular and capsular ligaments, the periosteum, the very texture of the finger-bones, and the pulpy substance underneath the nail, are all parts to which a whitlow may extend its mischievous consequences.

From what has been already observed, it must be plain that whitlows differ very much in their degree of violence, and in their depth and extent. Hence, surgical authors usually describe four or five varieties of the complaint. The division adopted by Callisen comprehends five cases; namely, the *cutaneous* or *superficial paronychia*, the *subcutaneous paronychia*, the *paronychia of the tendons*, or *theca*, the *paronychia of the periosteum*, and the *subungual paronychia*, or that *situated underneath the nail*.

The *cutaneous paronychia* begins with a superficial inflammatory redness of the finger, and, as early as the second or third day from the commencement of the attack, the cuticle of the part affected becomes raised in the form of vesicles, which contain a limpid serum, but sometimes a bloody fluid. (Callisen, vol. i. p. 294.) Mr. Pearson describes the cutaneous paronychia as being seated at the end of the finger, immediately below the cuticle, and as sometimes surrounding the finger and root of the nail. The skin, he says, is very little discoloured. The case speedily advances to suppuration; and when this process is completed, the cuticle appears almost transparent. After the contents of this little abscess are evacuated, the ulcer seldom demands any particular attention. Principles of Surgery, p. 88. edit. 2.

The *subcutaneous paronychia* makes its appearance in the form of an inflammatory tumour, attended with a great deal of acute pain. The symptoms, however, are not alarming,

nor do they generally extend beyond the inflamed finger. In severe examples, the whole hand is more or less affected with pain and tension, and uneasiness is felt all up the arm. The severity of the pain, in such cases, frequently prevents sleep, and the whole system is thrown into some disorder. The attack of this kind of whitlow is attended with a more acute and throbbing pain than that of the cutaneous paronychia, suppuration proceeds more slowly, and matter is frequently formed under the nail. The disease is particularly situated in the cellular membrane under the cutis.

The *more deeply-seated kinds of whitlow* are those affecting the sheath of the flexor tendons and the periosteum, which parts, indeed, by reason of their vicinity to each other, are often both attacked together. The disease commences with an intense, burning, shooting, throbbing pain in the finger, accompanied with severe febrile symptoms. At first, no swelling whatsoever can be perceived in the part affected; but afterwards a slight œdematous tumour follows, which gradually assumes an inflammatory appearance, and the tumefaction spreads from the finger to the hand, and forearm, and even to the axilla. On the inner side of the arm, red hard streaks may also frequently be observed, which are inflamed absorbent vessels tending to the axillary glands, which are themselves sometimes enlarged and very painful. The pain of the whitlow is particularly felt shooting up from the affected finger to the inner condyle of the humerus, and thence to the arm-pit. Delirium, and other alarming symptoms, occasionally attend these worst descriptions of whitlows, which are alleged to have proved sometimes fatal. The matter, which is small in quantity, is either collected within the sheath of one of the tendons, or it is under the periosteum in contact with the bone, which is generally found in a carious state; and sometimes the superincumbent integuments suffer sphacelation. See Pearson's Principles, p. 90.

The *subungual paronychia*, or that which especially occurs under the nail, commences with inflammatory symptoms, which are, however, much less urgent and dangerous than those of the preceding case; and the situation of the disease renders its nature quite obvious.

The usual exciting causes of whitlows are various external injuries, as pricks, contusions, &c. The lodgement of a thorn or splinter in the part, is another frequent cause of these abscesses. They are, however, much more common in young healthy persons than in others; and they appear in many instances to occur spontaneously, that is to say, without our being able to assign any manifest cause for them. There is one particular sort of whitlow, which Mr. Pearson has thought proper to call *venereal*, as will be presently noticed.

With regard to the prognosis in ordinary examples of the complaint, it may be laid down that the cutaneous and subcutaneous paronychiæ are in general unattended with danger. But those whitlows which are formed within the theca of the flexor tendon, if they be not relieved by the timely interference of surgery, very often produce abscesses, extending up the hand and arm, in the course of the corresponding tendon and muscle, which parts become so altered and diseased, that their functions are permanently injured, and the bones of the finger destroyed by necrosis. When also the periosteum is affected, the matter lying underneath, or closely upon it, the neighbouring phalanx of the finger generally perishes. Whitlows beneath the nail frequently occasion a loss and separation of the part.

The indications in the treatment of whitlows are;

1. To endeavour to produce an early resolution of the inflammation; but as this attempt seldom succeeds, and the case almost proceeds to suppuration,

2. The

WHITLOW.

2. The great desideratum is to discharge the matter as soon after its formation as possible.

3. The last thing is to heal the wound.

With respect to the first indication, experience proves, that the inflammation, in a very early stage of the complaint, may sometimes be dispersed by the adoption of ordinary antiphlogistic treatment. Here topical bleeding, especially the prompt and repeated application of leeches to the painful part several times in the day, is highly commendable; and the inflamed finger and hand may be covered with a cold, discutient, saturnine lotion, together with which means some writers advise the whole limb to be bound with a circular roller. Others speak lightly of the good effects of an early immersion of the affected finger in very warm water, or in lotions made of alcohol, vinegar, oil of turpentine, &c. and used as hot as can be borne. Callisen states, that he has also frequently observed great benefit arise from the affusion of such lotions on the part. He even asserts, that the pain and more deeply-seated inflammation of the finger may be sometimes checked by applying caustic or a blister to the integuments. When the patient's sufferings are very great, the exhibition of opium is indispensable after bleeding has been duly practised. The same writer also affirms, that electricity has been found useful at the very commencement of a whitlow.

When two days elapse without any probability of resolution taking place, suppuration ought to be promoted by the immediate and continued use of emollient poultices and fomentations. Nor should the surgeon wait for the abscess to point, but make an opening with less loss of time, in proportion as the case becomes worse. In examples where the pain is exceedingly violent, the incision should not be deferred beyond the fourth day from the beginning of the pain. The opening ought also to be made at the part which was first painful, and thence the cut should be continued longitudinally, and as deeply as the situation of the matter. The lancet, indeed, if requisite, must be introduced down to the bone, by which means a small quantity of deeply-seated confined matter may frequently be voided, and the pain and progress of the disease at once stopped. Even when no matter is discharged from the opening, an early incision sometimes speedily relieves very severe cases of whitlow; probably (as Callisen observes) on the principle of removing tension, and occasioning hemorrhage from the part. In those instances, in which an incision has not been practised in due time, and the matter under the tendinous sheath has spread extensively up the hand and arm, it is sometimes necessary to make the opening free and ample, without injuring, however, the annular ligament. The discharge of the abscess, and the evacuation of blood from the incision, are followed by almost immediate relief. When the matter is lodged under the periosteum, the bone is mostly found affected with necrosis. In cases of this description, there are some practitioners who prefer the removal of the diseased phalanx, to awaiting a tedious and uncertain cure by the processes of nature. Callisen, however, informs us, that he has often seen the dead portion of the bone exfoliate, leaving the rest in a state of preservation.

When a whitlow under the nail cannot be dispersed, the matter should be let out by an opening, practised through the transparent part of the nail, or by the side of it. Some surgeons adopt the plan of scraping the nail, so as to render it as thin as possible, before they cut through it, which is an ingenious and commendable method. See Callisen's *Syst. Chir. Hod.* t. i. p. 293. 295.

In the fifth volume of the *Medico-Chirurgical Transac-*

tions, Mr. Wardrop has described a very inveterate and troublesome species of whitlow, which, from its malignant character, he has called the *onychia maligna*. "The commencement of this disease is marked by a degree of swelling, of a deep red colour, in the soft parts at the root of the nail. An oozing of a thin ichor afterwards takes place at the cleft, formed between the root of the nail and soft parts, and at last the soft parts begin to ulcerate. The ulcer appears on the circular edge of the soft parts at the root of the nail; it is accompanied with a good deal of swelling, and the skin, particularly that adjacent to the ulcer, has a deep purple colour. The appearance of the ulcer is very unhealthy, the edges being thin and acute, and its surface covered with a dull yellow, or brown-coloured lymph, and attended with an ichorous and very fetid discharge. The growth of the nail is interrupted, it loses its natural colour, and at some places appears to have but little connection with the soft parts. In this state (says Mr. Wardrop), I have seen the disease continue for several years, so that the toe or finger became a deformed bulbous mass. The pain is sometimes very acute; but the disease is more commonly indolent, and accompanied with little uneasiness. This disease affects both the toes and the fingers. I have only observed it on the great toe, and more frequently on the thumb, than any of the fingers. It occurs, too, chiefly in young people; but I have also seen adults affected with it."

With regard to the treatment of the species of whitlow named by Mr. Wardrop *onychia maligna*, all local applications have in many instances proved quite ineffectual, and the part been amputated. The only local treatment which Mr. Wardrop has ever seen relieve this complaint has been the evulsion of the nail, and afterwards the occasional application of escharotics to the ulcerated surface. We have seen a similar plan occasionally succeed, and the applications which appeared to answer best were, arsenical lotions, Plunket's caustic, or a very strong solution of the nitrate of silver. Nothing, however, will avail till the nail is removed, and its total separation sometimes takes up a good deal of time, unless the patient submit to the great pain of having it cut away.

Mr. Wardrop tried with success the exhibition of mercury in four cases of the *onychia maligna*. The medicine was given in small doses at first, and afterwards increased, so as to affect the gums in about twelve or fourteen days. The fores in general soon assumed a healing appearance when the system was in this state, and the bulbous swelling gradually disappeared. Wardrop in *Medico-Chir. Transf.* vol. v. p. 135, &c.

Mr. Pearson has published an account of a peculiar sort of whitlow, to which he affixes the epithet *venereal*. He observes, that it generally appears in the form of a smooth, soft, unresisting tumour, of a dark red colour, and is situated in the cellular membrane about the root of the nail. It is attended with an inconsiderable degree of pain in the incipient state; but as suppuration advances, the pain increases in severity. The progress of the abscess to maturation is generally slow, and is seldom completed.

When the matter is evacuated, the nail is generally found to be loose, and a very foul but exquisitely sensible ulcer is exposed; and considerable sloughs of cellular membrane, &c. come away, so as to render the fore sometimes very deep. The discoloured and tumid state of the skin commonly extends along the finger, considerably beyond the margin of the ulcer. In such cases, the integuments of the finger become remarkably thickened, and the cellular membrane is so firmly

firmly condensed, as not to permit the skin to glide over the subjacent parts. The bone is not usually found in a carious state.

According to the same author, this species of whitlow is more frequently seen among the lower class of people, when they labour under lues venerea, than in the higher ranks of life. It does not appear to be connected with any particular state of the disease, nor is it confined to one sex more than the other. In the Lock Hospital, it is said to occur in the proportion of one patient in five hundred.

In adopting the name of *venereal paronychia*, Mr. Pearson informs us, that it is not with the design of implying that the case is a true venereal abscess, the matter of which is capable of communicating syphilis to a sound person. Its progress and cure, he observes, seem to be unconnected with the increased or diminished action of the venereal poison in the constitution, and to be also uninfluenced by the operation of mercury. Mr. Pearson considers the venereal disease as a remote cause, which gives occasion to the appearance of this as well as of several other diseases, which are widely different from its own specific nature.

In the incipient state of the venereal whitlow, when no severe symptoms are present, Mr. Pearson thinks it best to use no external applications, and merely cover the part with a bit of fine rag. The disease will then often gradually disappear of itself, without coming to suppuration. When matter is formed, Mr. Pearson says, the abscess may be permitted to burst spontaneously. Every species of dressing will frequently be found to give great pain, and disagree with the sore. The same writer, however, states, that one application, composed of equal parts of the balsam of copaiva and tinctura thebaica, may sometimes be used with a good effect. The principal object is to keep the patient as easy as possible, by the internal use of opium, until the sloughs are separated, and the ulcer becomes clean. It may then be treated as a common sore: Peruvian bark will also be generally proper. In the thickened diseased state of the integuments, Mr. Pearson condemns amputation, as being likely to produce a stump, which will change into a sore, resembling that for which the operation was performed. See Pearson's Principles of Surgery, edit. 2.

It is not at all clear to us, that Mr. Wardrop's case, which he terms the onychia maligna, is not actually the same disease as what Mr. Pearson has named the venereal whitlow. The only doubt arises from the former gentleman's recommending the exhibition of mercury as a means of cure; while the latter declares, that the complaint is quite uninfluenced by the operation of this medicine. We confess, that although some hundreds of cases of very bad whitlows have fallen under our observation, we have never met with any instance in which the cure seemed to require mercury.

WHITLOW in the Feet of Sheep, in *Rural Economy*, a disease that takes place in the latter end of summer, and which is more frequent among the long than the short sort of sheep. It but seldom happens in clean sheep-walks, though it is very troublesome on soft, dirty, pasture-lands. It is frequently occasioned in the milking season, by the boughts or folds being dirty, and by the sheep being confined in the old houses. It is of the inflammatory nature, and commonly affects the fore-feet, but sometimes all four. The outer part of the hoof is the usual seat of the disease, and from the cleft a sharp fetid humour exudes, sometimes engendering maggots, and corroding the flesh, nay even the bone. All around the hoof there is an inflammation, which turns black, and this part sometimes drops off. It is a very painful affection, so much so, that the animal often crawls.

As the weather gets more cold, it commonly becomes better, but it still walks in a lame manner.

On the appearance of the disease the foot is to be examined, and the diseased part opened to let out the acrid matter. It is then to be washed well, and dressed with mercurial ointment and sulphur in mixture, or tar with red precipitate, binding it up with a flannel bandage, to preserve it warm and clean. In case it does not take on suppuration, but degenerates into a foul and tedious ulcer, such applications as spirit of turpentine and sulphuric acid may be proper. And in all cases the sheep should be kept in a clean, easy, dry pasture, until it becomes well. See FOOT-ROT.

WHITLOW-GRASS, or Mountain Knot-Grass, in *Botany*. See PARONYCHIA, or ILLECEBRUM.

WHITLOW-GRASS is also a name given to some species of draba.

WHITLOW-GRASS, Rue-leaved, a species of saxifrage.

WHITSTABLE, in *Geography*, a village and sea-port of England, in Kent, near the mouth of the Swale. Here is a considerable oyster-fishery, which employs upwards of 70 boats. Some colliers likewise bring hither coals for Canterbury and the neighbourhood; 7 miles N. of Canterbury. N. lat. $51^{\circ} 22'$. E. long. $1^{\circ} 21'$.

WHITSUN ISLAND, an island in the South Pacific ocean, discovered by captain Wallis on Whitsun-eve, in the year 1767, about four miles long and three wide, surrounded by a reef. The boat's crew got some cocoa-nuts, and some scurvy-grass: they met with none of the inhabitants, but some huts and several canoes building. No anchoring place for the ship could be discovered. S. lat. $19^{\circ} 26'$. W. long. $137^{\circ} 56'$.

WHITSUN, or Whitsunday Island, or Pentecost, one of the New Hebrides, in the South Pacific ocean, about thirty miles in length, and eight in breadth. S. lat. $15^{\circ} 44'$. E. long. $168^{\circ} 20'$. See NEW HEBRIDES.

WHITSUN Farthings. See PENTECOSTALS.

WHITSUNDAY'S PASSAGE, in *Geography*, a strait so called by captain Cook, from the day on which he failed through it, in 1770; between Cumberland island and the coast of New Holland.

WHITSUNTIDE, the fiftieth day after Easter.

The season properly called *Pentecost*, is popularly called *Whitsuntide*; some say, because in the primitive church, those who were newly baptized came to church between Easter and Pentecost, in white garments.

WHITSUNTIDE Bay, in *Geography*, a bay on the north coast of the island of Kodiack, west of Cape Whitsunday.

WHIT-TAWER, in *Rural Economy*, a provincial term applied to a collar-maker for team-horses.

WHITTINGHAM, in *Geography*, a town of Vermont, in the county of Windham, with 1248 inhabitants; 16 miles E. of Bennington.

WHITTLE, a provincial name applied to a sort of pocket or sheathed knife.

WHITTLEBURY FOREST, in *Geography*, a royal forest of England, in Northamptonshire.

WHITTLESEA MERE, a lake of England, in the county of Huntingdon, formed by a branch of the river Nen, situated to the S.E. of Peterborough.

WHITTLESEY, or WHITTLESEA, a town in the north part of the hundred of Witchford, Isle of Ely, and county of Cambridge, England, is situated on the confines of Northamptonshire and Lincolnshire, at the distance of 10 miles W.S.W. from the town of March, and 5 miles E. by N. from Peterborough. It contains two parishes, St. Mary's and St. Andrew's; but their boundaries cannot be distinctly

distinctly ascertained, and they are so far consolidated, that, though in separate patronage, the two livings are generally held by the same person; and only one register of births and burials is kept for both. Whittlesey formerly had a market; but when or by whom granted, there are no existing records. The market-day was Friday; but it has long been gradually falling into disuse, and since the year 1788 has been wholly discontinued. An annual fair for horses is still held. Each parish has a church, in which are various sepulchral memorials of ancient families. St. Andrew's church was given to the monks of Ely in the twelfth century, by Nigellus, second bishop of that see, for the purpose of augmenting their library, or, as it is expressed by an historian of that time, "making books for the library." At the west end of St. Mary's church is a very handsome tower, surmounted by a tall and elegant spire, which from its height constitutes a very conspicuous object from distant parts of this flat country. The tower is much ornamented with niches, pinnacles, and quaterfoils; and each angle of the octangular spire, which connects with the angular pinnacles of the tower by flying buttresses, is adorned with foliated crockets. There is in the town a charity-school for the instruction of twenty-seven children, and several almshouses.

Whittlesey, exclusive of the town, is divided into five districts, named Ellry, Cotes, Eldernal, Willow-hall, and Glassmoor. At Eldernal was a chapel, consecrated in 1525, but long since dilapidated. At Glassmoor were found, about the year 1742, several Roman lamps made of the red ware. The population of the whole, in the return of the year 1811, is stated to be 4248, occupying 729 houses. Lysons's *Magna Britannia*, vol. ii. Cambridgehire, 1808.

WHITTON, a town of England, in Lincolnshire, on the side of the Humber; 15 miles N.N.W. of Glamford Briggs.

WHOLAGUNGE, a town of Hindoostan, in Oude; 12 miles N.E. of Fyzabad.

WHOLDYACHUCK, a lake of North America. N. lat. 60° 20'. W. long. 109° 30'.

WHOLE, TOTUM, in *Arithmetic*, &c. See PART, DIVISION, PARTITION, &c.

WHOLE, in *Logic*, is distinguished into four kinds; viz. a *metaphysical*, when the essence of a thing is said to consist of two parts, the genus and the difference; *mathematical* or *integral*, when the several parts which go to make up the whole are really distinct from one another, and each of them may subsist apart; *physical* or *essential*, usually denoting and including the two essential parts of man, body and soul, but more properly including all the essential modes, attributes, or properties, contained in the comprehension of any idea; and *logical*, called also *universal*, the parts of which are all the particular ideas to which this universal nature extends. Watts's *Logic*, p. 117.

WHOLE *Blood*, *Measure*, *Number*, and *Sine*. See the substantives.

WHOLE *Milk-Cheese*, in *Rural Economy*, a term used to signify such cheeses as are made from the whole meal of milk, in contradistinction to those which are made from a part of it only. It is observed in the Gloucester Report on Agriculture, that coward-cheese ought to be made of the whole meal of milk; but in a dairy of twenty cows, it is not unusual to set by a pan, of about seven or eight gallons, till the next milking, which is then skimmed, and added to the new meal, from which a similar quantity is taken as before. The cream thus laid by is made into milk-butter. Coward-cheeses are either thin, about eight

to the hundred; or thick, generally called double Gloucester, about four to the hundred, or even larger. The latter are made in May, June, and July, principally, and even as long as grass continues good in some dairies.

It is noticed, too, in the same sort of report for the county of Peebles, in Scotland, that in the sheep-farms there, where sheep's-milk cheese is made, the whole of that sort of milk is seldom employed; but that the whole of the cow's milk upon the farm is mixed with the sheep's milk. That the butter, during this period, being ill-tasted, is kept for mixing with the tar for smearing the sheep; and the milk is afterwards made into cheese. There are, in consequence, very few farms where cheese is made of entire sheep's milk; and that, from the various proportions of the admixture of cow's milk, there are few articles in commerce passing under one common denomination, of which the qualities are so various as those of sheep's-milk cheese. See DAIRYING, and CHEESE.

WHOLE-Moulding. The impropriety of continuing whole-moulding in the construction of ships, has been pointed out in the article SHIP-BUILDING: but as it is at present continued in the formation of boats; therefore, how far whole-moulding may be used in the construction of boats, we shall endeavour to explain by introducing a boat, which might be whole-moulded from the stem to the stern-post, if part of the midship-bend was approved of for the shape of the transom; but as there can be no necessity that it should be so far whole-moulded, we shall omit it to the stern-post, but extend it quite forward to the stem.

The length, stem, and stern-post, being determined on in *Plate Ship*, fig. 1, the next thing is the station of the midship-frame, which is not of material consequence, only let it be before the middle of the boat. Then set off all the stations of the timbers afore and abaft the midship-bend.

The height in the midships being given, draw the sheer-line, or top of the gunwale, so that it may have an agreeable appearance. The line below it shews the breadth of the sheer-strake, and the ticked line above it shews the upper edge of the wash-board.

The next thing is the rising-line, which requires some experience to determine at once, so as to answer every purpose; for not only the form of the midship-bend, but likewise the design of the boat must be kept in mind, to know how far we may venture to lift the rising-line afore and abaft, without occasioning any hindrance to her stowage.

Having determined the height of the rising-line, dispose of the main height of breadth-line at the midship-bend, at such height as will best suit the intended form of the midship-bend, and continue it from thence forward and aft, parallel to the rising-line; for so far as the boat is to be whole-moulded, the main height-of-breadth and rising-line must be parallel to each other in the direction of the square timbers.

In the half-breadth plan, fig. 2, square down from the sheer-plan, fig. 1, when the height-of-breadth line crosses the fore part of the rabbet of the stem, and the aft part of the rabbet of the stern-post, or aft-side of the transom. But as this line rises above the transom abaft, observe where the top of the side crosses the aft part of the transom, and draw it parallel down from any of the stations of the timbers. Also square down the station of the midship-bend.

Set off from the middle-line, A B, fig. 2, the half-thickness of the stem, and from thence sweep an arch to the thickness

thickness of the board used for the bottom, the back of which arch will give the ending of the fore part of the main-half-breadth line. Then set off the half-breadth to the outside of the timber at the midship-bend, and draw *CD* parallel to *AB*. Determine the breadth of the transom at the top of the side, and set off the half-breadth on the line for the aft-side of the transom.

Thus we have three spots, one at the aft-side of the transom, one at the midship-bend, and one at the stem, through which draw an unlimited curve; observing to make it faint about half the length of the boat in midships, and to form the bow by part of a circle.

To form the Midship-bend.—Draw the horizontal line *AB* (*fig. 3.*), and erect a perpendicular in the middle; then take the half-breadth of the boat at the midship-bend, in *fig. 2.*, and set it off on each side the middle-line, and erect the perpendicular *CD*. Take the height from the line *AB*, *fig. 1.* (which is the upper edge of the rabbet of the keel) to the rising-line, and to the height-of-breadth line at the midship-bend; and set off above the line *AB* on the perpendicular *CD*, *fig. 2.*, and draw the lines marked *M B*, and “Rising.”

The distance from the rising-line to the height-of-breadth line is the radius of the circle intended for the midship-bend; which distance, set off from the point where the half-breadth line intersects the side perpendicular, *c*, on the height-of-breadth line, will give the centre for the sweep of the midship-bend; then sweep an arch from the intersection of the perpendicular *c* to the intersection of the rising-line.

From the middle-line set off the half-breadth of the keel on the line *AB*, and draw a straight line from the side of the keel to the back of the arch of the midship-bend: let the top of the side above the height-of-breadth line be perpendicular, complete the other side of the middle-line the same from perpendicular *D*.

To form the square Timbers of the Fore-Body.—Take the distance from the line *AB*, *fig. 1.* to the rising-line at timber *A B*, &c. as far forward as timber *I*, and set them off, and draw lines parallel to the line *AB*, *fig. 3.* from the middle-line towards the line *c*.

Then take the distance from the line *AB*, *fig. 1.* to the height-of-breadth line at each separate timber, and draw them as before in *fig. 3.* parallel to *AB*.

Then take the half-breadth of each timber, *A B*, &c. in *fig. 2.* and apply each separate distance from the middle-line in *fig. 3.* on the lines of their corresponding names for the height-of-breadth, and there make a spot.

Make a mould agreeable to the shape of the midship-bend, the lower part to agree with the rising-line of the midship-bend, and extend as far beyond the middle-line as is necessary.

Cross the height-of-breadth on the mould, and the middle-line, when it lies well with the midship-bend.

Take the distance from the line *CD*, *fig. 2.* to the main-breadth line at timber *A B*, &c. and set them off from the middle-line on the lower side of the mould, towards perpendicular *c*, which shews the narrowing of each timber more than the midship-bend.

From the height-of-breadth line in *fig. 1.* take the distance to the top of the sheer-strake at each of the above timbers, and set them off above the main-breadth, on the mould, which gives the heads of all the timbers in the fore-body.

The lower edge of the mould is supposed to be the height of the rising-line from the timbers.

Then apply the lower edge of the mould on each rising-

line, *fig. 3.* and move it till each letter on the lower edge of the mould agrees with the middle-line, and the main-breadth on the mould agrees with its corresponding height-of-breadth line. Then draw the form of the mould from the head of the timber to the middle-line, as ticked in *fig. 3.* and draw a straight line from the side of the keel, at the upper edge of the rabbet, to touch the outside of the curve formed by the mould, except where the rabbet of the keel and stem rises, as at *F, G, H, I*.

Set off the half-thickness of the keel from the middle-line, *fig. 3.* and take the height from the line *AB*, *fig. 1.* to the lower edge of the rabbet at each timber, and set it off from the line *AB*, *fig. 3.* on the line for the half-thickness of the keel or stem; then with compasses set to the thickness of the bottom plank, sweep an arch; from the upper side of which draw a straight line to the back of each curve of the mould, which will finish completely the heels of the timbers.

The same method must be observed in the after-body towards perpendicular *D*, *fig. 3.* applying the midship-bend mould in the same manner as directed in the fore-body, making use of the mould as far aft as timber *12*.

The after-square timber is *9*; therefore, to *9* may be finished the heels of the timbers, by drawing a straight line from the back of the whole-moulding curve to the back of the sweep at the rabbet of the keel.

In whole-moulding, but few moulds are necessary to be made to mould all the timbers. Thus the floor-mould is to be made to the midship-bend in *fig. 3.* a little above the diagonal line, *ab* or *ac*, which is to be the heads of the floors, and let the lower part of the mould correspond well with the rising of the midship-bend, as is shewn in *fig. 4.*

When the mould lies well, as in *fig. 3.* mark the middle-line on the lower edge of the mould, and the head of the floor on the outer edge. Make the inside of the mould to its proper scantling, and let the upper edge correspond well with the cutting-down of the inside of the midship-floors; which cutting-down is so marked in *fig. 1.*

Then in *fig. 2.* take the distance of each timber from the line *CD* to the main-half-breadth line, and set them off on the lower edge of the mould, from the middle-line of the midship-bend towards the outer end of the mould, which is the middle-line for each floor.

Now fix the lower edge of the mould in *fig. 3.* on each rising-height, in the same manner as the timbers were got in by whole-moulding; and when each mark on the mould is well with the middle-line, and on its proper rising, describe on the outer edge of the mould the heads of the floors, or the diagonal line *ab*, or *ac*.

Or, as in *fig. 4.* square the middle-lines of each timber, and then take the half-breadths of each floor from *fig. 3.* and set them off square from each middle-line in *fig. 4.* to intersect the edge of the mould.

The lower Futtock-Mould, fig. 5. is made to the rising-height of the midship-bend, and from thence to the top of the sheer; but need not be made so long at the heel as the floor-mould. The inside is made to the scantling, and the crossing of the middle-line and the floor-head, on the lower futtock-mould, is done in the same manner as on the floor-mould; or the best way is to lay the floor-mould on the lower futtock-mould, and cross it by the floor-mould. When the lower futtock-mould is laid in its place to the midship-bend in *fig. 3.* then mark the main-breadth on the mould, which is the main-breadth for all the timbers. Then take the distance in *fig. 1.* from the main-breadth line to the top of the sheer at each timber, and set it off on the mould, from the main-breadth

WHOLE-MOULDING.

breadth upward, which is the heads of all the timbers; and then the crossing of the lower futtock-mould is finished.

To cross the rising Square.—When the boat is whole-moulded, the floors and lower futtocks are generally moulded by the use of the rising-square; which is so called, because when the square is properly placed to mould any timber, one side of the square corresponds with the rising of that timber. When the timbers are moulded by the outside of the mould, and the heels by the rising-square, (which gives the upper edge of the rabbet of the keel, or bearding-line,) then there is a batton, called a cutting-down batton, with the heights of all the floors, from the upper edge of the rabbet of the keel to the cutting-down line; which gives the cutting-down or inside of all the floors.

To make the rising-square, let one side of the square be of sufficient breadth to receive the rising and the cutting-down, as may be seen by the square E.

When moulding the floors, or lower futtocks, the lower side of the mould is the rising of the timber; and consequently the edge of the square, which is to be applied to the under side of the mould, is also the same.

Then to mark or cross the square, take the distance from the rising-line in *fig. 1*: to the upper edge of the rabbet of the keel, or bearding-line, at each timber; and set them off from that edge of the square which is to be applied to the mould, on the other edge of the square, and close to the edge, drawing a margin to put the letters or figures under them. Then take the distance in *fig. 1*. from the rising-line to the cutting-down line, at the timbers, where the cutting-down is below the rising, and set them off from the edge of the square that is to be applied to the mould on the other edge of the square, but within the risings, as may be seen on the square. The other timbers, from 3 to B, where the cutting-down is above the rising, may be marked on the moulds.

From the edge of the square where the risings are placed, set off on the other edge of the square the half-thickness of the keel, which call the middle-line; and then the square is ready for moulding.

To mould the Floors.—The best way for moulding the floors for a whole-moulded boat, is to make two moulds, agreeable to the former directions, made and crossed both alike, but the sides reversed. Then lay one on the other, the same as in *fig. 4*, keeping the lower edges in a straight line, and mooring them till the corresponding middle-lines on the moulds agree. The moulds in *fig. 4*. are fixed at 9, but the middle-lines on the lower mould cannot be seen; therefore, before the moulds are put together, it is best to mark (in chalk) on the edges of the mould the middle-lines of the timber. When the moulds are placed, fix the middle-line, marked on the edge of the square, to the middle-line on the mould of the timber, and the other edge of the square will represent the side of the keel.

Then apply a straight batton to the rising of 9, on the edge of the square, and also to the outside of the floor-mould. This will give the moulding of the outside of the floors, except timber 9, which is somewhat hollow. Then square the cutting-down for 9, across to the edge of the square, and draw a straight line to touch the inside of the mould.

In the same manner mould the other arm of the floor, by canting the square. But the rising and cutting-down should be marked on both sides.

Before the moulds are moved, mark the heads and firmarks, if any, as a guide to fix the lower futtock when put in its place, if it should not run down to the side of the keel.

To mould the lower Futtocks.—The lower futtock-mould is *fig. 5*, which is made in the same manner as the floor-mould, but continued as high as the top of the sheer. The upper part being straight and perpendicular, and the mould made to the scantling, there is no difference between moulding one side of the floors and moulding the lower futtocks.

The same method of fixing the square for the moulding of the floors will serve to mould the lower futtocks, as on the square in the plate, where the middle-line on the square is put to the middle-line on the lower futtock-mould for G. A straight batton applied to the rising for G, on the square, and to the back of the lower futtock-mould, gives the moulding of the outside of the lower futtock; and the cutting-down for G on the square brought to the edge of the square, a straight batton from thence to the inside of the mould will also be the inside of the lower futtock.

Mark the firmark, or floor-head, in the same manner as the floors, in order to place the lower futtock to its proper height at the side of the floors, in case they should not be required to run down to the side of the keel.

Likewise mark the main-breadth, and the head for G, before the mould is moved.

That there is no difference between the floors and the lower futtocks in using the rising-square, may be seen more clearly in *fig. 4*, where the floor-mould is continued up to the top of the side, which makes the lower futtock-mould; so that the form of the lower futtock is seen, as well as the floor.

The two floor-moulds may be made to serve for all the floors, by putting the fore-body on one side of the mould, and the after-body on the other; but observe to cross one mould opposite to the other, so that when it is canted over, it shall then be proper to mould with.

Two rising-squares are sometimes used; one for the fore-body, and the other for the after-body; because the squares must be crossed alike on both sides, to mould the arms of the floors, and likewise to mould the lower futtock for both sides of the boat. Or, instead of this, the fore-body may be put on one side of the square, and the after-body on the other. When the square is wanted on the opposite side, chalk on the edge of the square the rising and the cutting-down for the timber to be moulded, and then cant the square.

Two lower futtock-moulds may also be made, or cross the fore-body on one side of the mould, and the after-body on the other. In order to mould a timber for that side of the ship where the firmarks are at the under side of the mould, chalk the firmarks for the timber wanted on the edge of the mould; or make two margins on the edge of the mould, reserving one for the fore-body, and the other for the after-body, and reversed on the opposite side.

The lower futtocks for boats generally run about half way between the floor-head and the side of the keel; but if it were a hoy, or small vessel that was whole-moulded, the lower futtocks might then be required to run to the side of the keel, or dead-wood; wherefore, it is proper to shew the moulding of them down to the side of the keel.

Various are the methods used by different artificers in moulding the lower futtocks; and it is evident that the method which has been practised most will appear the best.

Some will make no use of the square, but mark the heels of the lower futtocks on the mould, and provide a batton, marked the same as the square; the lower end of the batton being long enough to mould the outside of the foremost and aftermost timbers; and the upper end of the batton being long enough to mould the inside of the midship-timber.

Mark

Mark a firmark across the batton, supposed to represent the side of the square, which must always be fitted well to the lower edge of the mould; from which firmark, supposed to be the rising for all the timbers, set off close to the edge of the batton the heels of all the timbers in the fore-body, or the distance in *fig. 1.* from the rising-line to the upper edge of the rabbet of the keel, or bearding-line.

Then draw a margin for the cutting-down of the timbers, and take the distance in *fig. 1.* from the rising-line of each timber to the cutting-down, and set them off on the batton for the cutting-down, as much above or below the firmark on the batton as the cutting-down is above or below the rising at each timber.

On the other side of the batton may be put the after-body.

In some boats or vessels, where the rising and cutting-down are farther asunder at the midship-bend, then the batton will be as useful as the square; but instead of the middle-lines being marked on the lower futtock-mould, it will be better to mark the side of the keel, or where the keels of the lower futtocks are intended to be, for the better applying the batton.

If the heels of the lower futtocks do not run down to the side of the keel, it will alter the risings on the batton; the heels being marked on the mould short of the side of the keel.

The proper heels of the lower futtocks should be marked on the mould, though moulded by the square; for then the edge of the square might be put to the proper mark on the mould for the heels of the timbers.

The middle-lines marked on the lower futtock-mould in the *Plate*, were intended only to shew that the method of moulding the floors and lower futtocks were alike. The square is the best to mould the floors, because the middle-lines are the properest to be marked on the floor-mould.

What has been said may suffice to shew that whole-moulding may, in some measure, be used, and yet form a pleasing draught, much more so than that of the boat in *fig. 1.* if less stowage were sufficient to answer the purpose for which she is designed.

WHOLE-SOME SHIP, in the *Sea Language*, one that will try, hull, and ride well, without rolling or labouring in the sea. A long ship that draws much water may try, hull, and ride well; but if she draws little water, she may try and ride well, but never hull well; and a short ship that draws much water may hull well, but neither ride nor try well; and such is called an *unwholesome ship*.

WHORE. See **COURTESAN**, **HARLOT**, **CONCUBINE**, &c.

WHORL, in *Botany*. See **VERTICILLUS**.

WHORLBAT, or **HURLBAT**, a kind of gauntlet, or leathern strap, loaden with plumbets; used by the ancient Romans in their solemn games and exercises; and by them called *castus*.

WHORLED PLANTS. See **VERTICILLATÆ**.

WHORLES of *Flowers*, among *Herbalists*, are rows of lesser flowers, set at certain distances about the main stalk or spike, as in penny-royal, &c.

WHORTLE-BERRY, **BILBERRY**, or **Cranberry**, in *Botany*. See **VACCINIUM**.

The whortle-berry, with one flower upon each footstalk, oval-sawed leaves, which fall off in winter, and an angular stalk, called *black whorts*, or *bilberries*, grows very common upon large wild heaths, in many parts of England, but is

never cultivated in gardens, it being with great difficulty transplanted; nor will it thrive long when moved thither. The fruit is gathered by the poor inhabitants of those villages which are situated in the neighbourhood of their growth, and carried to the market-towns. These are by some eaten with cream or milk; they are also put into tarts, and much esteemed by people in the North, but they are seldom brought to London.

The shrub on which these grow rises about two feet high, having many stems, which are garnished with oblong leaves, shaped like those of the box-tree, but somewhat longer, and a little sawed on their edges. The flowers are shaped like those of the arbutus, or strawberry-tree, of a greenish-white colour, changing to a dark red toward the top. The fruit is about the size of large juniper-berries, and of a deep purple colour, having a flue upon it when untouched, like the blue plums, which is rubbed off with handling.

The whortle-berry with nodding bunches of flowers terminating the branches, and oval leaves which are entire, turned back and punctured on their under side, called *vitis idæa*, and *red whorts*, is an ever-green shrub, seldom rising above six or eight inches high, with leaves like those of the dwarf-box, which grows upon moors in several parts of the North, but is not capable of being easily transplanted: the berries are red, and have a more agreeable acid flavour than those of the first sort.

The whortle-berries with oval, entire, reflexed leaves, and naked, slender, creeping stalks, called *moss-berries*, *moor-berries*, and *cran-berries*, produce branches small as thread, and trailing upon the mossy bogs, which are garnished with leaves resembling those of thyme, with the upper surface of a shining green, and white underneath. The berries, which grow upon long slender foot-stalks, succeeding the flowers, are round, red, and spotted, of a sharp acid flavour, and much esteemed for tarts, or eaten with milk or cream. This is a native of bogs, and cannot be propagated upon dry land.

There are several other species of this genus, some of which are natives of Spain and Portugal, others of Germany and Hungary, and several of the northern parts of America; from whence those large fruits are brought to England which are used by the pastry-cooks of London, during the winter season, for tarts. But as all these sorts grow naturally in swamps and bogs, they are not easily transplanted into gardens in their native country, so as to thrive or produce fruit; therefore, there can be little hope of cultivating them to advantage. Miller.

WHORTLE-BERRY, *African*, a species of **ROYENA**.

WHORTLE-BERRY, *Bear's*. See **UVA URSI**.

WHUR, in *Falconry*, denotes the fluttering of partridges or pheasants as they rise.

WHY-EA-TEA, in *Geography*, a bay on the east coast of Owhyhee. N. lat. 19° 44'. E. long. 204° 54'.

WHYMEA BAY, a bay on the north coast of the island of Woahoo. N. lat. 21° 38'. E. long. 202° 51'.

WHYMEA Road, a road on the south-west coast of the island of Attowai. Captain Vancouver says, this bay is much confined in respect to safe anchorage.

WHYTE, **ROBERT**, in *Biography*, an excellent composer of church-services in the style of Palestrina, which, however, he could not imitate, as he was anterior to him, and a great master of harmony before the productions of this chief of the Roman school were published, or at least circulated, in other parts of Europe. Whyte was dead in 1581, when his Latin Full Anthems and Services were beautifully transcribed in a set of books, still preserved at Oxford;

Oxford; as we find by a distich at the end of a prayer, in five parts, upon a plain song: "Precamur Sancte Domine."

Maxima musarum nostrarum gloria Whyte
Tu peris; æternum sed tua musa manet.

Whyte preceded Tallis and Bird, and died before their fame was well established. His works seem never to have been printed; but in the library of Christ-church, Oxford, a sufficient number of them has been preserved in the Aldrich collection, to excite not only wonder, but indignation, at the little notice that has been taken of them by musical writers. Morley, indeed, has given him a place in the list of composers at the end of his Introduction, and ranks him, with Orlando di Lasso, among *excellent men*, who had ventured to begin a composition with a fourth and sixth; he likewise places him with Fairfax, Taverner, Shepherd, Mundy, Parsons, and Bird, "famous Englishmen who have been nothing inferior to the best composers on the continent." And no musician had then appeared who better deserved to be celebrated for knowledge of harmony, and clearness of style, than Robert Whyte, as is manifested in Burney's *Hist. of Mus.* vol. iii. by an anthem for five voices.

But besides this masterly composition, and a great number of others, to Latin words, which were scored from the Christ-church books, and which were probably produced at the latter end of Henry VIII.'s reign, or during the time of queen Mary, when the Romish religion was still in use, we are in possession of a small MS., which, by the writing and orthography, seems of the 16th century, entitled "Mr. Robert Whyte, his Bitts, of three Parte Songes, in Partition: with Ditties, 11; without Ditties, 16." These are short fugues or intonations in most of the eight ecclesiastical modes, in which the harmony is extremely pure, and the answer to each subject of fugue brought in with great science and regularity. Burney.

WHYTHORNE, THOMAS, gentleman, in *Musical History*, author of a book of songs, printed by John Daye, in 1571, under the following title: "Songes of three, fower, and five voyces, composed and made by Thomas Whythorne, gentleman, the which songes be of fundrie fortes, that is to say, some long, some short, some hard, some easie to be songe, and some between both; also some solemne, and some pleasaunt or mery: so that according to the skil of the fingers (not being musitians), and disposition or delite of the hearers, they may here find songes to their contentation and liking."

Our secular vocal music, during the first years of Elizabeth's reign, seems to have been much inferior to that of the church, if any judgment can be fairly formed of it from this book, published before the songs of Bird had appeared, and of which both the words and the music are alike truly barbarous. But we have, in our own time, music-books published in England every day without genius or science to recommend them. And it is not certain that Whythorne's songs were ever in much public favour. Now, if it should happen that one of these, by escaping the broom of Time, should reach posterity, and fall into the hands of some future antiquary, critic, or historian, who should condemn *all* the compositions of the present age by *one*, that had, perhaps, been never performed or heard of by contemporary judges and lovers of good music, the sentence would surely be very unjust.

WHYTT, ROBERT, F. R. S. in *Biography*, a distinguished physician, was born at Edinburgh in 1714, educated at St. Andrew's, and studied physic first at Edinburgh, and afterwards at London, Paris, and Leyden. He settled in his pro-

fession at Edinburgh, where he became a fellow, then president of the college of physicians, and in 1746 chairman of the institutions of medicine in the university. As a medical practitioner and teacher, and also as a writer, he acquired celebrity. The first of his publications was an "Essay on the Vital and other Involuntary Motions of Animals," 1751, in which he advances a theory different from that of Stahl, as he attributes these motions not to the soul, acting to a foreseen end, but to the power of stimulus. In 1755 he published "Physiological Essays, containing an Inquiry into the Causes which promote the Circulation of the Fluids in the very small Vessels of Animals; with Observations on the Sensibility and Irritability of the Parts of Man and other Animals." Here he supposes that the action of the heart is not sufficient to propel the blood through the minutest vessels, but that it is assisted by an oscillatory motion of the vessels themselves. Of this work, an enlarged edition appeared in 1761. His other works are, "An Essay on the Virtues of Lime-water in the Cure of the Stone," 1752; "Observations on the Nature, Cause, and Cure of those Disorders which are commonly called Nervous, Hypochondriac, and Hysteric," 1764; and some papers in the Edinburgh "Essays and Observations, Physical and Literary." A posthumous work appeared, entitled "Observations on the Dropsy of the Brain." Having long laboured under a complication of chronic complaints, he died in 1766. His son published an edition of all his works in 1768, 4to. under the inspection of sir John Pringle. Haller Bib. Anat. Gen. Biog.

WIA, in *Geography*, one of the small western islands of Scotland, a little to the south of Benbecula. N. lat. 57° 22'. W. long. 7° 11'.—Also, one of the small Western islands, near the east coast of Barray. N. lat. 56° 58'. W. long. 7° 22'.—Also, a small island near the west coast of Skye. N. lat. 57° 21'. W. long. 6° 27'.

WIAMPA, or WINITA, or *Sinpa*, a town of Africa, on the Gold Coast, in the district of Agonna.

WIANDOTS. See WYANDOTS.

WIAPOCO, or LITTLE WIA, one of the navigable mouths of the Oroonoko.

WIBALDUS, in *Biography*, a person of note in the 12th century, descended from a noble family in the bishopric of Liege, completed his studies at Liege, and became a teacher first at Vasso, and afterwards at Stablo. In 1130 he was elected abbot; and in 1136 he accompanied the emperor Lotharius on his expedition to Italy, by whom he was employed in several important departments, and fixed as abbot in the monastery of mount Cassino. But he quitted this monastery in the following year, and returned to Germany. In 1146 he became abbot of the monastery of Corvei on the Weser, in which he was confirmed by king Conrad, to whom he was no less an object of confidence than he had been to Lotharius. He was no less a favourite with Frederic I., who had sent him twice as ambassador to Constantinople; but on his return from his last mission thither, he terminated his life at Buleltia, in Paphlagonia, in consequence, as it is said, of poison, which had been given to him in the month of July, 1158. His Letters, mixed with some other works, one volume of which only remains, throw considerable light on the state of society at that time, and on the ecclesiastical history of Germany. Gen. Biog.

WIBLINGEN, in *Geography*, a town of Bavaria, with a Benedictine abbey, near the conflux of the Iler with the Danube; 3 miles S.S.W. of Ulm.

WIBORGIA, in *Botany*. See VIBORGIA.

WIBURG, in *Geography*. See VIBORG.

WIBY, a town of Sweden, in the province of Nericia; 18 miles S.W. of Orebro.

WIC, denotes a place on the sea-shore, or on the bank of a river. Though in the original Saxon, it more properly signifies a *street, village, or dwelling-place*; as also a *castle*. See WYKE.

We often meet with *wic* in the Saxon writers, as a termination of the name of a town which had a complete name without it: as, *Lunden-wic*, that is, London-town; which signifies no more than *London*. In the Saxon Annals, it is mentioned, that king Ethelbert made Melitus bishop of *Lunden-wic*.

So, Ipswich is written in some old charters, *will de Gippo*, and sometimes *villa de Gippo wico*; which is no variation, but the same thing; for *Gipps* is the complete name, and the *Gipp-wic* is Gipps-town.

WICCAKAW, in *Geography*, a town of the state of Georgia; 22 miles N.N.W. of Oakfuskee.

WICHRA, a river of Saxony, which rises three miles N. of Waldenburg, and runs into the Pleiss, 2 miles N. of Borna.

WICHTIS, a town of Sweden, in the province of Nyland; 27 miles N.N.W. of Helsingfors.

WICHRACH, a town of Switzerland, in the canton of Berne; 12 miles S.S.E. of Berne.

WICK, a royal borough, market-town, and the county-town of the shire of Caithness, Scotland, is situated at the entrance of the small river Wick, the estuary of which forms a good harbour, at the distance of 279 miles N. from Edinburgh. The town is small, and the streets narrow and confined; but there are several respectable buildings to ornament the place. The church is an old, dark, and ill-constructed edifice. A weekly market is held on Fridays, and is well supplied. The chief sources of commerce and industry are the fisheries, which are prosecuted with great attention and success. The town and borough-lands of Wick were anciently part of the earldom of Caithness: on the petition of George, then earl, a charter was granted by James VI. of Scotland, Sept. 24, 1589, erecting the town of Wick into a royal borough, under the superiority of that nobleman. In 1672 the whole earldom of Caithness was disposed of to John Campbell, afterwards created earl Breadalbane, by whose successors it was sold to the family of Sinclair, in whom the superiority is still vested. In 1716 the convention of royal boroughs fixed the sett or government of the borough of Wick. By this sett, the old magistrates nominate two persons, out of whom a provost and two baillies are to be chosen by the free burgeses: the provost and two baillies so elected have the right of choosing seven counsellors, a treasurer, and a dean of guild. Wick, in conjunction with the boroughs of Dingwall, Dornock, Kirkwall, and Tain, sends one member to parliament. The parish of Wick is twenty miles long and ten broad; and in the population return of the year 1811 is stated to contain 5080 inhabitants. Carlisle's Topographical Dictionary of Scotland, 4to. 2 vols. 1813. Gazetteer of Scotland, 1806. Beauties of Scotland, vol. v. Caithnessshire.

Wick, a river of Scotland, which runs into the Northern ocean, at Wick, in the county of Caithness.

WICKER, a twig of the osier shrub, single or wrought.

WICKER-Basket, in *Rural Economy*, any sort of basket which is made of wicker-work, or the plaited or twisted twigs of the willow, or other such kinds of young shoots. See BASKET.

A sort of wicker-basket or braid, too, is made use of

in grafting in field, orchard, or fruit grounds. It is observed in the Gloucestershire Report on Agriculture, that the grafts are secured immediately after the compost is put on, with "braids." These are open wicker-baskets in the form of an inverted cone, fitting the stock below the place to which the compost extends, and rising about two feet high, and expanding at the top to nearly the same diameter. This contrivance serves not only to guard the grafts in their early state, but also to keep the shoots to a proper compact form of growth. The practice chiefly prevails on the banks of the Severn, where the osier (*salix viminalis*) is grown in great abundance.

In hop-grounds likewise large wicker-baskets are employed for picking the hops into. See HOP.

And wicker-work of the basket kind is made use of for many other purposes of different sorts.

WICKER-Tree, a name given by the English to a tree common in China, and described by Kircher and others. It is, as it were, a rope twisted by nature, about an inch thick, and creeps along the earth often for above a hundred paces together, much embarrassing the way, but serving for cables of ships, seats, hurdles, beds, mats, and various other necessary uses. It endures no vermin, and is much valued for being cool and refreshing in the hot seasons.

WICKER-Work, in *Agriculture*, a sort of basket-work on a large scale, used for defending land from water of the sea or other kinds. It is observed by Mr. Loudon, in his work on "Country Residences," that in some very sandy shores, defences of the embankment kind may be made of wicker-work; and that three or four rows of paling may be made of different heights, and the intervals between them be filled with furze, brushwood, straw, or any other such materials. It is thought that these materials would retain the sand as the tide passed through among them; and that in a very short time a defence or fort of embankment would be formed of the shelving kind, which should then be planted with the upright sea lime-grass, in order to bind it. See EMBANKMENT, and WATER, *Sea, Defending Land from*. Also UPRIGHT *Sea Lyme-Grass*, and ELYMUS *Arenarius*.

WICKERAD, in *Geography*, a town of France, in the department of the Roer. It gave name to a lordship, surrounded by the duchy of Juliers; 3 miles N.E. of Erkelens.

WICKET, of the French *guichet*, a little door within a gate; or a hole in a door, through which to view what passes without.

WICKFORD, in *Geography*, a town of Rhode island, with a post-office; 10 miles N.W. of Newport.

WICKHAM, commonly called *Market-Wickham*, to distinguish it from two other places of the same name in the county, is a village and parish in the hundred of Wilford, and county of Suffolk, England. It has been a place of much greater consequence than it is at present, and had a weekly market and town-hall, where the quarter-sessions were held. The spiritual courts for the archdeaconry of Suffolk are still held here. The parish-church, being built on a hill, constitutes a land-mark for vessels sailing by the coast. From the tower, a spectator may see nearly fifty other churches. An aisle, or chapel, on the south side of the church, was built by Walter Fulburn, of this parish, who died, and was buried within its walls, in 1489. The rectories of Wickham, Pettistree, and Bing, all in the hundred of Wilford, were bequeathed in 1718 by Mr. John Pemberton for charitable uses. According to the population report of 1811, this parish contained 133 houses, and 906 inhabitants. It is 12½ miles N.E. of Ipswich, and

and 81 in the same direction from London. The market, which was formerly held on Saturdays, has long been discontinued.—*Beauties of England and Wales*, vol. xiv. Suffolk, by F. Shoberl.

WICKHAM *Breaux*, and WICKHAM *Streyth*, the names of two other parishes in Suffolk, England.

WICKLIFFISTS, or WICKLIFFITES, in *Ecclesiastical History*, a religious sect, who had their rise in England in the 14th century, and their name from their leader *John Wickliffe*.

Wickliffe, of whose opinions we give some account in his biographical article, (see WICKLIFF,) denied that bishops were of a different order from priests, and that by virtue of their office they had any power to do what priests have not; and that in the apostolic times the two orders subsisting in the church were those of priest and deacon. With regard to tithes, he observes, that we do not read in the Gospel where Christ paid tithes, or commanded any man so to do; and that if they were due by God's commandment, there should be every where in Christendom one manner of tithing; and that those things which are due to priests should be given freely, without exaction or constraining. In opposition to the papal claims of supremacy and dominion, he maintained that the grants of emperors may be refused; that St. Peter and his successors have no rights conferred upon them of civil or political dominion; that the persons of the clergy and the goods of the church are not exempted from the civil powers; and that bulls of absolution or excommunication are conditional and not absolute, and depend for their effects on the disposition and character of those to whom they pertain.

Wickliffe defines heresy to be error maintained against holy writ, and that in life and conversation, as well as in opinion. He ventured to affirm, that children who die without baptism may be saved; that this rite does not confer grace, but only signify that which was before given; and he denied that all sins are abolished by baptism. But in these and some other points, occurring in his various works, which were published at different times, he is not always perfectly consistent; but in all matters of principal importance he is uniform.

He left many followers in England and other countries, who were called Wickliffites and Lollards, and who held their opinions in private without making any public profession of them; though they were generally known by their disparaging the superstitious clergy, whose corruptions were so notorious, and their cruelty so enraged, that it was no wonder the people were much prejudiced against them. Wherever they could be found, they were terribly persecuted by the inquisitors, and other instruments of papal vengeance.—*Lewis's History*, &c. 8vo. passim. *Mosh. Eccl. Hist.* vol. iii. 8vo. *Burnet's Hist. Reform.* vol. i. p. 23.

WICKLOW, in *Geography*, a maritime county of Ireland, on the east coast, having the county of Dublin on the north, the Irish sea on the east, the counties of Kildare, Dublin, and Carlow, on the west, and that of Wexford on the south. Its extent from north to south is 32 Irish ($40\frac{1}{2}$ English) miles; from east to west, 26 Irish (33 English) miles; and the superficial contents are 311,600 acres, or 486 square miles, equal to 500,600 acres, or 780 square miles English. Mr. Radcliffe, according to the county map, states the superficial contents at 305,404 Irish acres. There are 58 parishes, which have 20 churches, mostly in the archbishopric of Dublin. Dr. Beaufort states the population at 58,000. "A great part of Wicklow is rendered unfit for habitation, and incapable of culture, by mountains intermixed with rocks and bogs. How-

ever, though the heart of the county be a cheerless waste, the hills on the east and west sides, and especially along the coast, are from six to eight miles in breadth, being many of them well wooded, and intermixed with profitable and smiling valleys, form a delightful and various scenery. They are crowded with gentlemen's seats, and are not without small towns and villages." This was Dr. Beaufort's account in 1792. In 1801, captain Frazer published a statistical account for the Dublin Society. This gentleman laments, that "the Wicklow farmers foul the land by repeated corn-crops, and seldom or never lay it down to graze with seeds." He deplores "the total neglect of the improvement of the breed of animals for stock and labour;" and under the head of ploughs he remarks, "the common plough in use in this district is the swing-plough; it is seldom, however, formed on any scientific principles, and is generally very clumsy, and ill-adapted for making clean or regular work." In 1812, however, when the Rev. Thomas Radcliffe published a Report of the Agriculture and Live-Stock of the County of Wicklow, a very great change had taken place. A few extracts from this interesting publication will furnish the reader with the most authentic information on the state of this county, and of what has been effected by the exertions of the Farming Society of Ireland, its own local Farming Society, and the encouragement as well as example of good landlords.

The climate of the county is, in general, mild; but on the eastern side, along the sea-coast, is peculiarly warm, and favourable to vegetation; inasmuch that there is almost a perpetual spring; and land of an apparently light quality is known to produce crops equal, if not superior, to those on the richest soils in other parts of Ireland. The crops commonly cultivated are, potatoes, wheat, barley, and oats. With respect to potatoes, the valuable system of drilling is almost universally adopted. The quantity of wheat is inconsiderable: it is generally taken after the potatoe-crop, sometimes after another white crop, or upon the lea; but the periodical fallow for wheat is fortunately unheard of. The barley-crop is taken after potatoes or turnips, and, like the wheat, is sown under the plough. The oat-crop, by the common practice, is taken upon the lea; but if upon stubble-ground, it is sown under the plough. The crops are not exceeded in quantity or quality in any part of Ireland. Green crops are not in much use among the tenantry. The manure in this county, besides dung, consists of brown, blue, and white marl, lime and lime-stone gravel. In the greatest part of this county, the implements of the best construction are in very general use; such as the Scotch plough, as recommended and supplied by the Farming Society, the Scotch harrow, the Scotch cart, drill-machines, and even the threshing-machine. Most of the improved breeds of cattle have been introduced into this county; but Wicklow cannot be considered as a breeding county. The dairies are numerous; but, on a contracted scale, averaging from eight to sixteen cows, and almost uniformly engaged in the feeding of veal for the Dublin market. In the northern part of the county, much of the milk is consumed in fattening early lamb. The county of Wicklow, though not to be classed as a breeding county with respect to cattle, is very extensively so with respect to sheep, its vast tracts of mountain supplying a wholesome, though not an exuberant, pasture to that animal. The breed of this county is the mountain kind; and the number of breeding ewes may be stated at 20,000. The South Down are the favourites with the gentlemen; and many flocks of the native mountain have been crossed with South Down. The Merino sheep have also been successfully introduced. The

cotton manufacture is carried on with spirit at Stratford-upon-Slaney. The woollen manufacture is chiefly limited to the flannel-trade. This, however, is carried on largely, and is a source of fair profit and industrious occupation. It prevails on the property of earl Fitzwilliam, and the Flannel-hall at Rathdrum was built at his lordship's expence. The average annual sale is about 5000 pieces of 120 yards each.

The romantic beauties of this county have been often described. The vicinity to Dublin makes them easily accessible, and few travellers omit to visit them. The antiquities of Glendalough have been noticed in the proper place, under that name. The mineralogy of Wicklow has been noticed in Dr. Fetton's valuable Notes on the Mineralogy of the Neighbourhood of Dublin; and on this head Mr. Griffith's Report on the Mountain District of Wicklow should also be consulted. This uncultivated district has many peculiarities, which consist chiefly in the facility of access by means of roads; the vicinity of highly improved lands and industrious inhabitants; the frequent occurrence of beds of lime-stone, gravel, and marl; the best manure for the amelioration of mountain soils; and the uncommon mildness of the climate. These uncultivated lands occupy about 200,000 Irish acres, of which about 60,000 consist of black bog; the remainder is moory soil, generally covered by coarse sedgey grass, or grass intermixed with heath. In this district, many rivers have their sources. The Liffey, with its tributary streams, takes a circular course through the county of Kildare, and falls into the bay of Dublin; the Slaney runs southward to the county of Wicklow; the Fartrey disembogues itself at Wicklow; and the Ovoca at Arklow. (For an account of the Cronbane mines, see CRONEBANE.) At Croghan Kinshela, in the southern part of the county, a quantity of native gold has been extracted by washing from the alluvial soil, of which an account, by Messrs. Mills and Weaver, may be found in the Transactions of the Dublin Society. Near 600 ounces of gold, worth above 2000*l.*, were extracted; but the vein could not be discovered, and the search for it was given up. Oxyd of tin was found in the same stream. The county of Wicklow has no large town, and has only the two members for the county to represent it in parliament.—Frazer's Survey. Beaufort's Memoir. Radcliffe's Report. Griffith's Report, &c.

WICKLOW, the assize-town of the preceding county, which is also a post-town. It is pleasantly situated on a small harbour, and near a beautiful strand abounding in fine pebbles, which is called the Murrough. The ale of Wicklow has been long celebrated in Dublin. It is 24 miles S.S.E. from Dublin.

WICKWA, a small lake of Canada, at the eastern extremity of Lake St. John.

WICKWAR, anciently WICKEN, a market-town in the hundred of Grombold's Ash, in the county of Gloucester, England, is situated 19 miles S.W. from Gloucester, and 108 miles W. from London, and consists of one long street. The town is incorporated and governed by a mayor and twelve aldermen. It has a weekly market on Monday, and two yearly fairs. In it two courts are held; one for the borough, and another for the tything, or foreign, which have separate constables. The clothing manufacture, which once flourished here, has long been on the decline; but the lower classes are still employed in spinning for the clothiers of other places. Wickwar contains a well-endowed free grammar-school, which was founded in 1684. The church, a handsome building on an eminence, consists of a nave and north aisle. The rectory is valued in the king's books

at 18*l.* The resident population in 1801 was 764; in 1811 it had increased to 805.—Hist. of the County of Gloucester, by the Rev. Thomas Rudge, B.D. Gloucester, 1803, 2 vols. 8vo.

WICLIFF, DE WYCLIF, WICLEF, or WICKLIFFE, JOHN, in *Biography*, the earliest reformer of religion from Popery, was born about the year 1324 in Yorkshire, near the river Tees, in a parish whence he takes his name. He was educated at Oxford, first as a commoner of Queen's college, and then at Merton college, peculiarly celebrated at that period for its learned members. His industry and talents soon raised him to distinction; and he is said to have committed to memory the most abstruse parts of Aristotle, and to have excelled in his acquaintance with the subtleties of the school divinity. He was also eminently skilled in civil and canon law, and in the law of the land. But the study which led to his future fame was that of the Scriptures; to which he added a diligent perusal of the Latin fathers, and of the writings of the English divines, Robert Groshead and Richard Fitz-Ralph. In his treatise "Of the Last Age of the Church," at the early period of the year 1356, he remonstrated against some Popish corruptions; and in 1360 he was active in opposing the encroachments of the Mendicant Friars, who interfered with the jurisdiction and statutes of the university, and took all opportunities of enticing the students from the colleges into their convents. In the following year, such was the credit he had acquired by his conduct and writings, he was appointed master of Baliol college, and was presented to a living in Lincolnshire. At this time he was held in such esteem by archbishop Simon Islip, that in 1365 he constituted him warden of Canterbury college, which he had just founded; but on occasion of a dispute between the regular and secular priests, Wickliffe and the three secular fellows were rejected; and on an appeal to Rome, the sentence against Wickliffe was confirmed in 1370. His reputation in the university was not at all diminished by his exclusion. In 1372 he took the degree of D.D., and read lectures, which gained him such applause, that whatever he said was regarded as an oracle. The impostures of the monks were the objects to which his first attacks were particularly directed; and the circumstances of the times favoured his design. The court of Rome was now enforcing by menaces its demands on king Edward III. of the homage and tribute to the see of Rome, which had been ingloriously stipulated by king John; and the parliament had determined to support the king in his refusal. A monk appeared as an advocate on behalf of the claims of Rome; and Wickliffe's reply caused him to be favourably regarded at court, and procured for him the patronage of the king's son, John of Gaunt, duke of Lancaſter. In 1374 Wickliffe was joined in an embassy to Bruges, the object of which was to confer with the papal nuncios concerning the liberties of the English church, on which the usurpations of Rome had made unwarrantable encroachments. In the same year the king presented him to the valuable rectory of Lutterworth, in Leicestershire; and in the following year he was installed in a prebend of the collegiate church of Westbury, in Gloucestershire. Wickliffe, by his foreign mission, had an opportunity of acquainting himself with the corruption and tyranny of the court of Rome; and both his lectures and conversations were amplified with invectives against the pope. Whilst he defended the authority of the crown and the privileges of the nobles against all ecclesiastical encroachments, he censured vice and corruption in all ranks of society. This conduct, though it raised his reputation among the people, excited a host of enemies, who selected from his writings nineteen articles, which they deemed heretical, and which,

WICKLIFF.

as such, they transmitted to Gregory XI. In 1377 this pontiff returned three bulls addressed to the archbishop of Canterbury and the bishop of London, ordering the seizure and imprisonment of Wickliffe; or, if this measure failed, his citation to the court of Rome; and also a requisition to the king and government to assist in extirpating the errors which he had propagated. Edward died before the bulls arrived; and the duke of Lancaster, uncle to the young king, had great influence in the administration. When Wickliffe, therefore, was cited to appear at St. Paul's church before the two prelates, possessing plenitude of power, he thought it necessary to secure himself by the protection of that powerful patron. On the appointed day he appeared at St. Paul's, in the midst of a vast concourse of people, and accompanied by the duke of Lancaster, and lord Henry Percy, earl-marshal. The bishop of London was very in signant, and angry words passed between him and the two lords; so that the whole assembly was tumultuous, and nothing was done. Wickliffe afterwards appeared before the two prelates in Lambeth palace, and delivered an explanation of the articles objected against him. The Londoners, who were apprehensive that he might be severely treated, flocked in crowds to the palace; and a messenger from the queen forbade the delegates to proceed to a definitive sentence. Gregory soon after died, and his commission expiring with him, Wickliffe escaped, but not without a severe illness, which was the consequence of his anxiety and fatigue. His spirits, however, were unbroken, and he was firm in maintaining opinions which the friars, by all the efforts of intimidation, urged him to renounce.

Upon his recovery, he presented to the parliament, in 1379, a paper against the tyranny and usurpations of Rome; and he also drew up some free remarks on the papal supremacy and infallibility. But his most effectual attack on the corruption of religion was his translation of the Bible into English. This occupied many of the last years of his life, and remains a valuable relic of the age in which it was performed, and a permanent memorial of the talents and industry of the person by whom it was accomplished. (See *English BIBLES*.) By way of preparation for his Bible, he published a treatise "Of the Truth of the Scripture," in which, as well as in a prologue or preface to his translation, he held, long before any of our other reformers or advocates for the sufficiency of Scripture, that this is the law of Christ, and the faith of the church; that all truth is contained in it; and that every disputation which has not its origin thence is profane. "The truth of the faith," says he, "shines the more by how much the more it is known—nor are those heretics to be heard who fancy that seculars ought not to know the law of God, but that it is sufficient for them to know what priests and prelates tell them by word of mouth; for the Scripture is the faith of the church, and the more it is known in an orthodox sense the better; therefore, as secular men ought to know the faith, so it is to be taught men in whatsoever language is best known to them. Besides, since the truth of the faith is clearer and more exact in the Scripture than the priests know how to express it—it seems useful that the faithful should themselves search out and discover the sense of the faith, by having the Scriptures in a language which they understand.—The laws which the prelates make are not to be received as matters of faith; nor are we to believe their words or discourses any farther or otherwise than they are founded on the Scripture;"—with much more to the same purpose, and in the same admirable strain. In this preface, and several other publications and treatises still in manuscript, he reflected severely on the corruptions of the clergy, condemned

the worship of saints and images, the doctrine of indulgences, pilgrimages to particular shrines, and confession; and also denied the corporal presence of Christ in the sacrament, inveighed against the wanton exercise of the papal power, and opposed the making of the belief of the pope's being head of the church an article of faith and salvation, censured the celibacy of the clergy, forced vows of chastity, exposed various errors and irregularities in the hierarchy and discipline of the church, and earnestly exhorted all people to the study of the Scriptures.

In his lectures of 1381, he attacked the Popish doctrine of transubstantiation, concerning which he laid down this fundamental proposition; viz. that the substance of bread and wine still remained in the sacramental elements after their consecration, and that the host is only typically to be regarded as the body of Christ; and he deduced from it sixteen conclusions. This attack alarmed the church, which regarded transubstantiation as the most sacred tenet of the Romish religion, and the chancellor of Oxford pronounced a condemnation of these conclusions. Wickliffe appealed from this sentence to the king; but he found himself deserted by his protector, the duke of Lancaster, who had no further occasion for his services, or who could not avail himself for any political purpose of his theological discussions. Thus circumstanced, he found himself in danger; his resolution failed him, and he humbled himself by making a confession at Oxford, before the archbishop and six bishops, with other clergy, who had already condemned some of his tenets as erroneous and heretical. In this confession, he admitted the real presence of Christ's body in the sacrament, with some explanations and reasons which were not satisfactory to his persecutors. It has been said that he made a public recantation of the opinions with which he was charged; but of this no sufficient evidence appears. The next step in their proceedings against him was a royal letter, procured by the archbishop, addressed to the chancellor and proctors, and directing them to expel from the university and town of Oxford all who should harbour Wickliffe or his followers, or hold any communication with them. These proceedings obliged him to withdraw, and to retire to his rectory at Lutterworth, where he continued to preach reformation in religion, and finished his translation of the Scriptures. Some have said that king Richard banished him out of England; but if that were the case, it was only a temporary exile, and he returned in safety to Lutterworth. In 1383 he had a paralytic stroke, which furnished him with an apology for not appearing to a citation of pope Urban VI.; and this was succeeded by a second attack, which terminated his life on the last day of December 1384. His remains, however, did not escape the vengeance of his enemies many years after his death; for the council of Constance in 1415, not content with condemning many propositions in his works, and declaring that he died an obstinate heretic, with impotent malignity ordered his bones to be dug up and thrown upon a dunghill. This sentence was executed in 1428, in consequence of a mandate from the pope, by Flemming, bishop of Lincoln, who caused his remains to be disinterred and burnt, and the ashes to be thrown into a brook. "Thus," says Fuller, the church historian, in a figurative strain justified by fact, "this brook hath conveyed his ashes into Avon, Avon into Severn, Severn into the narrow seas, they into the main ocean; and thus the ashes of Wickliffe are the emblem of his doctrine, which now is dispersed all the world over." His doctrine not only survived these impotent attempts to extinguish it, but was perpetuated and diffused by his followers, who were called Lollards; and "this germ of reformation," as one of his biographers

biographers says, "broke forth into complete expansion, when the season for that great change was fully come." Of his general character, it will be sufficient to say, "that he was confessedly learned for his age, and was an acute reasoner. In short, notwithstanding certain errors and imperfections, he may be regarded as a person of extraordinary merit and qualifications, who is entitled to honourable remembrance from every foe to ecclesiastical tyranny and imposture;" and we may add that he advanced principles which have not yet produced their full effect.

The number of tracts he wrote and published, both in Latin and English, is very considerable. From two large volumes of his works, entitled "Aletheia, i. e. Truth," and a third under the title of "Triologus," John Hufs is said to have derived most of his doctrines. We have a full and complete "History of the Life and Sufferings, and various Writings of Wickliffe," both printed and MS., published in 8vo., at London, in the year 1720, by Mr. John Lewis; who also published, in 1731, "Wickliffe's English Translation of the New Testament from the Latin Version, called the Vulgate." This translation is enriched with a learned preface by the editor, in which he enlarges upon the life, actions, and sufferings of this eminent reformer. Biog. Brit. Mosh. Eccl. Hist. Neal's Hist. of the Puritans. Gen. Biog. For an account of his distinguishing tenets, and those of his followers, see WICKLIFFISTS and LOLLARDS.

WICOMICO, in *Geography*, a river which rises in the state of Delaware, enters the state of Maryland, and passes into Fishing bay, on the east side of the Chesapeake, N. lat. 38° 16'. W. long. 75° 57'.

WICOMOCO, a river of Virginia, which runs into the Chesapeake, N. lat. 37° 55'. W. long. 76° 25'.

WICQUEFORT, ABRAHAM, in *Biography*, was born at Amsterdam in 1598, and having left his own country for France at an early age, he was nominated resident for the elector of Brandenburg at the French court, and held the office for thirty-two years. But being suspected by cardinal Mazarin of communicating secrets to his correspondents in Holland with regard to the amours of Lewis XIV., he was ordered, in 1658, to leave the kingdom; but in the mean time he was arrested, and confined in the Bastille. At length, in 1659, he was released and dismissed. However, in three months the cardinal recalled him, and settled on him a pension. On occasion of the war between France and Holland in 1672, he returned to his own country, and was protected by John de Witt, who employed him in writing a history of Holland to his own time. In 1676 he was arrested and condemned to perpetual imprisonment, under an accusation of carrying on a secret correspondence with the enemies of the state; and after having been confined for three years, he made his escape by the contrivance of one of his daughters. He then sought refuge at the court of Zell, from which he returned to Holland in 1681, where he lived without molestation, but without recovering the places of which he had been deprived. In the following year, 1682, he died. The work on account of which Wicquefort is best known, is entitled "L'Ambassadeur et ses Fonctions," first printed at the Hague in 2 vols. 4to. 1681, and often reprinted. He holds in high estimation the privileges of the order to which he belonged, as we may infer from his censure of Cromwell's spirited act of justice in executing the brother of the Portuguese ambassador for a murder: nevertheless he inculcates sound morality with regard to the conduct of diplomatists in the countries to which they are sent. His other works are, "Memoires touchant les Ambassadeurs et les Ministres;" one volume of

his "History of the Dutch Republic," which appeared in French at the Hague in 1719, fol.; and translations into French of the accounts of different embassies, and also of voyages and travels. Moreri. Gen. Biog.

WICRANGLE, in *Ornithology*, an English name for the matticefs, or greater butcher-bird, the *lanius cinereus major* of authors.

WICRANTUM, in *Natural History*, a name given by the people of the East Indies to certain fossil bodies, of the nature of the pyrites, of the size of peas, and formed into variously angular figures.

They look black and glossy, and much of the nature of blende, or mock-lead; but when put into the fire, they shew us by their smell that they contain sulphur. They are found in the diamond-mines.

The natives first powder them; and then mixing them with the juices of certain plants, they dry them, and then calcine them again. These processes they repeat at least sixty times; but the first calcinations are made with a mixture of divers urines, as that of the horse, the camel, the cow, and the like.

After this tedious preparation, they are given in coughs and colds, and are said to be a remedy even in consumptions.

WICZENIECZ, in *Geography*, a town of Poland, in Podolia; 6 miles N.W. of Kamniec.

WIDAWA, a town of the duchy of Warsaw; 22 miles S.W. of Siradia.

WIDDAU, a river of Germany, which joins the Rodau at Rotenburg, in the county of Verden.

WIDDY, in *Agriculture*. See WITHY.

WIDE, is used in some places to denote a small vale, and also a wide piece of water, or pond.

WIDE-EARED, in the *Manege*, is applied to a horse, when the root, or lower part of his ear is placed too low, and the ear itself is too large. The French use the term *oreillard* for such a horse.

WIDE Bay, in *Geography*, a bay on the east coast of New Holland, between Double Island Point and Indian Head.

WIDE Mouth Bay, a bay of England, on the N.W. coast of Cornwall. N. lat. 50° 46'. W. long. 5° 19'.

WIDEKINDI, or WIDICHINDI, JOHN, in *Biography*, a Swedish historian, was born in the province of Westmanland, about the year 1620, and studied at Upsal, where he delivered an oration in 1654, on occasion of queen Christina's accession to the throne; and by her recommendation he was appointed historiographer of the kingdom. In 1676 he proposed printing his "History of Gustavus Adolphus," and measures were taken for this purpose; but he died at Stockholm in 1678, before the work was executed. The first part of this history was published in 1691, fol.; but as it much offended both the Danes and Russians, it was suppressed by the king's command. It is not known whether he completed the work in MS.; but the part published is written in a dull, heavy style, and it has been carelessly printed. The author, however, was a man of learning, well acquainted with history, and reckoned a good Latin poet. He possessed an excellent library, and was much respected by king Charles Gustavus, who called him his philosopher. The most important of his works, a catalogue of which is given in "Schefferi Svecia Litterata," is the "History of the Russian War," written both in Latin and Swedish, 1672, 4to. Gen. Biog.

WIDERDRIESS, in *Geography*, a town of the duchy of Stiria; 2 miles S. of Windisch Gratz.

WIDJITZE, a town of Bohemia, in the circle of Czaflau; 8 miles W. of Czaflau.

WIDMINNEN, a town of Prussia; 14 miles N.W. of Lick.

WIDOW, VIDUA, a woman that has lost her husband.

Some also use the term *widower*, for a man who has lost his wife. Marriage with a widow is a kind of bigamy in the eye of the canon law.

The widow of a freeman of London may use her husband's trade as long as she continues a widow.

Mr. Kerseboom has given us a table, shewing how long four hundred and thirty-two widows lived, and finds, that at a medium, each lived fourteen years. Phil. Transf. N^o 468, sect. 3.

It appears that, in Germany, the number of widows dying annually is four times the number of widowers: thus, in Dresden alone, the number of widows who died in four years was 584; the number of widowers 149: *i. e.* 4 to 1. At Wittenberg, during 11 years, 98 widowers died, and 376 widows. At Gotha, during 20 years, 210 widowers died, and 760 widows. And as widows are certainly, one with another, several years younger than widowers, it may be concluded that the number of the former in life together could not be less than five times the latter.

Thus also, in 1770, the number of widows in life, derived from the whole body of professors and ministers in Scotland, was 380; but the number of widowers among them has, one year with another, been scarcely 90; *i. e.* not so much as a quarter of the number of widows. Price's Observ. on Rev. Paym. eff. 4.

These facts cannot be accounted for without admitting the greater mortality of males. See MARRIAGE, and MORTALITY.

There have been many schemes established for providing annuities for widows, for an account of several of which, see Price's Observ. &c. chap. ii. sect. 1, 2, 3.

Among the ancient Greeks, widows had the care of the eternal fire of Vesta committed to them; which charge among the Romans could be performed by virgins only, who from their office were called vestals. See VESTAL.

WIDOW of the King, was she, who, after her husband's death, being the king's tenant in capite, was driven to recover her dower by the writ *De dote assignanda*; and could not marry again without the king's consent.

WIDOW *Beneb*, in the county of Suffex, is that share which a widow is allowed of her husband's estate, besides her jointure.

WIDOW'S Chamber, a name given in London to the apparel and furniture of the bed-chamber of the widow of a freeman, to which she is entitled.

WIDOW-Wail, in Botany. See CNEORUM.

WIDURIS, in *Natural History*, the name of a stone found in Java, Malabar, and some other places, and described by Rumphius. Some species of this are all over of a fine white; others are of a dusky colour, with streaks of white; the simply white ones are semi-pellucid, and look very like the white of an egg. Some also have called this the *hyalops*, or *achates vitrea perspicuitatis*.

WIECK. See WEEK.

WIED, in *Geography*, a county of Germany, situated to the north of Treves, in the year 1560, divided into two parts: the Lower County, or New Wied, or Wied New Wied; and the Upper County, or Wied Runkel. Both had seats in the college of Westphalia counts.

WIED, *New*. See NEUWIED.

WIED, or *Old Wied*, a town of Germany, in the county of New Wied; 9 miles N. of Coblentz.

WIEDENBRUCK, a town of Westphalia, in the bishopric of Osnabruck; 32 miles S.S.E. of Osnabruck. N. lat. 51° 45'. E. long. 8° 18'.

WIEDERAU, a town of Saxony; 5 miles N. of Liebenwerda.

WIEDERSBERG, a town of Saxony, in the Vogtland; 8 miles W.S.W. of Oelsnitz.

WIEDERSPACH, a town of Germany, in the margrave of Anspach; 6 miles W. of Anspach.

WIEGANDSTHAL, or WIEGENTHAL, a town of Upper Lusatia; 11 miles S. of Lauban.

WIEHE, a town of Thuringia; 26 miles N.N.E. of Erfurt. N. lat. 51° 18'. E. long. 11° 35'.

WIELAND, CHRISTOPHER MARTIN, in *Biography*, was the son of a Protestant clergyman at Biberach, in Swabia, where he was born in September 1733. Educated by his father, he began at the early age of thirteen to distinguish himself by his Latin and German poems; and he pursued his education at Magdeburg and at Erfurt. Upon his return home he became affectionately attached to Sophia de Guterman, afterwards known by her works under the name of Mad. de la Roche. In the year 1750 he studied jurisprudence at Tubingen; but his time was chiefly devoted to the writing of verses, so that in 1752 he published a didactic poem in six cantos, entitled "The Nature of Things;" "Ante-Ovid, or the Art of Love;" and "Moral Letters and Tales." He also began an epic poem, on the subject of Arminius, the first five cantos of which he sent to the famous Swiss poet Bodmer; and he was thus led to visit Switzerland, and to cultivate a friendship with this celebrated poet, and to reside for some time in his house at Zurich. In this retired and tranquil situation, he applied with great diligence to the study of the belles lettres, and acquainted himself with the principal modern languages, such as English, French, and Italian, to which he afterwards added the Spanish and Portuguese. He also read Plato with great attention, and wrote several works, among which were the "Trial of Abraham," and "Letters of the Dead." After a residence of seven or eight years in Switzerland, he quitted this country, having formed his taste on the models of Euripides, Xenophon, and Shaftsbury, whose writings he had diligently studied; and in 1758 he published his "Arafpes and Panthea," a work which manifests the ascendancy which judgment and moral sentiment had acquired over his imagination. Upon his return in 1760 to his native city, he was appointed a director of the chancery, which office he held till the year 1769, reserving, however, some leisure moments for the composition of his philosophical romance, entitled "Agathon," and his beautiful didactic poem "Musarion." About this time he became intimately acquainted with count Stadion, a nobleman who lived with splendour near Biberach, who had cultivated a taste for literature, and who possessed an excellent library. He afterwards received from the elector of Mentz an invitation to be professor of philosophy and the belles lettres at Erfurt, and during his residence in this place he became acquainted with Anna Amelia, duchess dowager of Weimar, a patroness of polite literature, and in 1772 she appointed him tutor to the two princes, Charles Augustus and his brother Constantine, of whom she was guardian. In this situation he occupied himself in preparing a variety of works, both in prose and verse, which have done honour to German literature. He was at this time aulic counsellor to the duke of Saxe Weimar, with a pension, and a counsellor of government to the elector of Mentz. Wieland married his favourite daughter Charlotte to a bookseller at Zurich, who was a son of the celebrated poet Solomon Gessner. In 1797 he visited

visited his children at Zurich, and resided with his family in a romantic situation on the border of the lake, where he was visited by the most eminent literati of Switzerland. Conceiving a fond attachment to a rural retreat, he sold his house at Weimar, and purchased a small estate in the neighbourhood, where he fixed his abode. Although his fortune was small, his disposition was liberal; and he assisted many distressed young poets and authors for their contributions to the German Mercury, which he commenced in the year 1783. To the ex-monk Reinhold, who had escaped from Vienna, he was a generous patron, and gave to him one of his daughters in marriage. This monk was afterwards professor of philosophy at Kiel. He also supported another monk, who had fled to him from a Cistercian monastery in Swabia, during his residence at Jena, where he studied philosophy. Wieland had married in 1765 a person of good family at Augsburg, of whom he expresses himself in the highest terms of respect and affection, and by whom he had thirteen children; "found," he says, "in body and mind; with their mother, they form the happiness of my life." In 1807 this venerable poet was elected a member of the floral order at Nuremberg; and in 1808, Buonaparte sent him the cross of the legion of honour. After the battle of Jena, he was protected by a special order of that conqueror. He died in January 1813, in his 80th year. For the delineation of his talents and character by Kuttner and others, and an account of his works, which were very numerous, we must refer to his article in the General Biography, observing that his original works have been published in thirty-six large 4to. volumes, and six supplementary volumes. Leipzig, 1794—1802.

WIELAS, in *Geography*, a town on the east coast of the island of Gilolo. N. lat. $1^{\circ} 9'$. E. long. $128^{\circ} 30'$.

WIELCZYNY, a town of Lithuania, in the palatinate of Novogrodek; 40 miles S.E. of Slonim.

WIELDEMAN. See **WILDEMAN**.

WIELEN, a town of the duchy of Warsaw; 46 miles N.W. of Posen.

WIELICHOW, a town of the duchy of Warsaw; 25 miles S.S.W. of Posen.

WIELICZA, a town of Austrian Poland, celebrated for its salt-mines, which produce a great revenue to the emperor, to whose lot it fell in the year 1773. The inhabitants reside chiefly in the mines, and the church is underground; 8 miles S. of Cracow. These salt-mines, with the territory belonging to them, were assigned to the emperor of Austria by the treaty at Vienna in 1815.

WIELONA, a town of Samogitia; 20 miles S. of Rosienne.

WIELUN, a town of Poland, in the palatinate of Siradia; 16 miles S. of Siradia.

WIEN, a river of Austria, which runs into the Danube at Vienna.

WIENNERHORBEG, a town of Austria; 12 miles W. of Brugg.

WIENNERWALD, or *The Forest of Vienna*, the south part of the arch-duchy of Austria, bordering on Hungary.

WIEPERZ, or **WIPNZ**, a river of Poland, which runs into the Vistula, near Stericzka, in the palatinate of Sandomirz.

WIEN, JOHN, in *Biography*, a physician, was born in 1515, at Grave on the Meuse; and being domesticated with the famous Cornelius Agrippa, adopted his opinions with regard to the occult sciences. After having studied at Paris and Orleans, he took the degree of M.D. about the year 1534. In the course of his travels, he visited the court

of the duke of Cleves, and was appointed his physician. He died at Tecklenburg, in Westphalia, in 1586. He was a man of considerable learning; and though participating in a great degree the credulity of the age, he incurred the enmity of the monks by ascribing to deception and imposture the forcery, witchcraft, and magical practices, which they supported, to the operation of natural causes. The turn of his mind is discernible in his book "*De Dæmonum Prestigiis et Incantationibus*." In his treatise of medical observations he has given an account of the putrid fore throat, under the name of "*Angina pestilentialis*." Among his other writings are enumerated "*De Iræ Morbo, et ejus Curatione Philosophica, Medica, et Philosophica*;" "*Tractatus de Commentitiis Jejuniiis*;" "*De Tuffi Epidemica, Anno 1580*;" "*De Varenis, Morbo endemio Westphalorum*." Haller. Eloy.

WIERINGEN, in *Geography*. See **VIERINGEN**.

WIERNITZ, a town of Austria; 8 miles N. of Korn-Neuburg.

WIESE, a town of Silesia, in the principality of Grotkau; 2 miles N.E. of Weydenau.

WIESEN, a river of Germany, which rises in the Black Forest, and runs into the Rhine a little below Bâle.

WIESENBACHE, a river of Saxony, which runs into the Weiffnitz, 4 miles N. of Dippoldiswalda.

WIESENBRUN, a town of the county of Castell; 14 miles E. of Wurzburg.

WIESENBURG, a citadel of Saxony, in the circle of Erzberg; 5 miles S. of Zwickau.—Also, a town of Saxony; 15 miles N.N.W. of Wittenberg.

WIESENFELD, a town of the duchy of Wurzburg; 5 miles S.S.E. of Gemunden.

WIESENSTEIG, a lordship of Bavaria, situated between the territories of Ulm and Wurtemberg, about eight miles long, and nearly as much in breadth. It descended from the dukes of Teck to the counts of Helfenstein, and gave name to a peculiar line. On the failure of the counts of this house, in the year 1627, in the person of count Rudolph, one-third of this lordship devolved to the house of Furstenberg, but the other two-thirds were purchased by the elector of Bavaria, of the two elder daughters of the last count; to this the dukes of Wurtemberg indeed would not give their consent, and in the year 1704 took possession of the lordship, but by virtue of the peace of Baden, concluded in the year 1714, were obliged to restore it to the elector of Bavaria.—Also, a town of Bavaria, and capital of a lordship of the same name; 25 miles S.E. of Stuttgart.

WIESENT, a town of Bavaria, in the bishopric of Bamberg; 3 miles E. of Forcheim.

WIESENTHAL, **BOHMUSCH**, a town of Bohemia, in the circle of Saatz; 25 miles N.W. of Saatz. N. lat. $50^{\circ} 23'$. E. long. $12^{\circ} 57'$.

WIESENTHAL, Ober, a town of Saxony, in the circle of Erzberg; 11 miles S.E. of Schwartzenberg.

WIESENTHAL, Unter, a town of Saxony, in the circle of Erzberg. All these towns are very near together, a small brook only separates the Bohemian town from the two German ones; 10 miles S.E. of Schwartzenberg.

WIESENTHAL, a lordship situated between the duchy of Wurzburg, the county of Castell, and the margravate of Anspach. It takes its name from a citadel belonging to the counts of Schonburg.

WIESPINCAN, a river of Louisiana, which runs into the Mississippi, N. lat. $41^{\circ} 22'$. W. long. $91^{\circ} 36'$.

WIESEN,

WIESSEN, a town of Germany, in the county of Rieneck; 10 miles N.W. of Löhre.

WIESTERBURG, a town of Westphalia, in the principality of Halberstadt; 7 miles N.E. of Osterwick.

WIETHEN, a lake of North America. N. lat. 62° 30'. W. long. 99° 50'.

WIETLISBACH, a town of Switzerland, in the canton of Berne; 20 miles N. of Berne.

WIETMARSEN, or WITTMARSCHEIN, a town of Germany, in the county of Bentheim, with an abbey, which formerly belonged to the Benedictines, and was in the 12th century secularized for noble ladies; 4 miles N. of Northorn.

WIFE, Uxor, a married woman; or one joined with, and under the protection of, a husband. See MARRIAGE.

A wife, in our English law, is termed *feme covert*; *femina viro co-operta*; her condition during marriage is called her *coverture*; and, in the judgment of the law, is reputed to have no will, as being supposed entirely under, and subject to, that of her husband: *uxor fulget radiis mariti*.

A man cannot grant any thing to his wife, or enter into covenant with her; for the grant would suppose her separate existence, and to covenant with her would be only to covenant with himself; and, therefore, it is generally true, that all compacts made between husband and wife, when single, are void by the intermarriage. A woman, however, may be attorney for her husband; and a husband may bequeath any thing to his wife by will, for that cannot take effect till the coverture is determined by his death.

From the unity of person that subsists between the husband and wife, in consequence of marriage, it follows, that whatever personal property belonged to the wife before marriage, is by marriage absolutely vested in the husband. In a real estate, he only gains a title to the rents and profits during coverture; for that, depending upon feudal principles, remains entire to the wife, after the death of her husband, or to her heirs, if she dies before him; unless by the birth of a child, he becomes tenant for life by the curtesy. But in chattel interests, the sole and absolute property vests in the husband, to be disposed of at his pleasure, if he chooses to take possession of them: for, unless he reduces them to possession, by exercising some act of ownership upon them, no property vests in him, but they shall remain to the wife, or to her representatives, after the coverture is determined.

There is, however, a considerable difference in the acquisition of this species of property by the husband, according to the subject-matter; viz. whether it be a *chattel real* or *personal*; and of chattels personal, whether it be in *possession*, or in *action* only.

A *chattel real* vests in the husband, not absolutely, but *sub modo*. As, in case of a lease for years, the husband shall receive all the rents and profits of it, and may, if he pleases, sell, surrender, or dispose of it during the coverture: if he be outlawed or attainted, it shall be forfeited to the king; it is liable to execution for his debts; and if he survives his wife, it is to all intents and purposes his own. Yet if he has made no disposition thereof in his life-time, and dies before his wife, he cannot dispose of it by will; for, having never been transferred from the wife, after his death she shall remain in her ancient possession, and it shall not go to his executors.

Thus also with regard to chattels personal (or *choses in action*), as debts upon bond, contracts, and the like; these the husband may have if he pleases; that is, if he reduces them into possession by receiving or recovering them at law:

in which case, they are absolutely and entirely his own: and shall go to his executors or administrators, or as he shall bequeath them by will, and shall not revert in the wife. But if he dies before he has reduced them into possession, so that at his death they still continue *choses in action*, they shall survive to the wife.

Thus in both the species of property the law is the same, in case the wife survives the husband; but, in case the husband survives the wife, the law is very different with respect to *chattels real* and *choses in action*; for he shall have the *chattel real* by survivorship, but not the *chose in action*; except in the case of arrears of rent, due to the wife before her coverture, which in case of her death are given to the husband by the statute 32 Hen. VIII. cap. 37.

As to *chattels personal* (or *choses in possession*), which the wife hath in her own right, as ready money, jewels, household goods, and the like, the husband hath therein an immediate and absolute property, devolved to him by the marriage, which can never again revert in the wife or her representatives.

The wife also, by marriage, acquires a property in some of her husband's goods, called her *paraphernalia*, which shall remain to her after his death, and shall not go to his executors. These, signifying the apparel and ornaments of the wife, suitable to her rank and degree, the husband cannot devise by his will; though during his life perhaps he hath the power (if unkindly inclined to exert it) to sell them or give them away. But if she continues in the use of them till his death, she shall afterwards retain them against his executors and administrators, and all other persons, except creditors where there is a deficiency of assets. And her necessary apparel is protected even against the claim of creditors.

The wife can make no contract without her husband's consent; and, in all law-matters, *sine viro respondere non potest*.

The husband is bound to provide his wife with necessaries by law, as much as himself; and if she contracts debts for them, he is obliged to pay them; but for any thing besides necessaries, he is not chargeable. Also if a wife elopes, and lives with another man, the husband is not chargeable even for necessaries, at least if the person who furnishes them is sufficiently apprized of her elopement.

If the wife be indebted before marriage, the husband is bound afterwards to pay the debt. If the wife be injured in her person or property, she can bring no action for redress without her husband's concurrence, and in his name as well as her own; neither can she be sued, without making the husband a defendant. There is indeed one case where the wife shall sue and be sued as a *feme sole*, viz. where the husband has abjured the realm, or is banished; for he is then dead in law. See CUSTOM of London.

In criminal prosecutions, the wife may be indicted and punished separately; for the union is only a civil union. But in trials of any sort, they are not allowed to be evidence for or against each other. However, where the offence is directly against the person of the wife, this rule has been usually dispensed with; and, therefore, by stat. 3 Hen. VII. cap. 2. in case a woman be forcibly taken away and married, she may be witness against such her husband, in order to convict him of felony. See FORCIBLE Abduction.

In the civil law, the husband and wife are considered as two distinct persons; and may have separate estates, contracts, debts, and injuries; and, therefore, in our ecclesiastical courts, a woman may sue and be sued without her husband.

But, though our law in general considers man and wife

as one person, yet there are some instances in which she is separately considered; as inferior to him, and acting by his compulsion. And, therefore, all deeds executed, and acts done by her during her coverture, are void; except it be a fine or the like matter of record, in which case she must be solely and secretly examined, to learn if her acts be voluntary. She cannot by will devise lands to her husband, unless under special circumstances; for at the time of making it she is supposed to be under his coercion. And in some felonies, and other inferior crimes, committed by her through constraint of her husband, the law excuses her; but this extends not to treason and murder. See *FEME-COVERT*.

The husband also, by the old law, might give his wife moderate correction; but this power of correction was confined within reasonable bounds, and the husband was prohibited from using any violence to his wife. The civil law gave the husband the same, or a larger authority over his wife; allowing him, for some misdemeanors, *flagellis et fustibus acriter verberare uxorem*; for others, only *modicam castigationem adhibere*. But, with us, in the politer reign of Charles II., the power of correction began to be doubted; and a wife may now have security of the peace against her husband, or, in return, a husband against his wife. The courts of law will still permit a husband to restrain a wife of her liberty, in case of any gross misbehaviour. Blackst. Com. book i. book ii.

If a wife bring forth a child during her husband's absence, though of many years; yet if he lived all the time *inter quatuor maria*, within the island, he must father the child; and the child, if first born, shall inherit. See *BASTARD*.

If a wife bring forth a child begot by a former husband, or any other person, before marriage, but born after marriage with another man; this latter must own the child, and that child shall be his heir at law.

The wife, after her husband's death, having no jointure settled before marriage, may challenge the third part of his yearly rent of land, during her life; and, within the city of London, a third part of all her husband's moveables for ever. See *DOWER*, *INTESTATE*, and *CUSTOM of London*.

The wife partakes of the honour and condition of her husband; but none of the wife's dignities come, by marriage, to her husband.

Yet, the husband, who marries a woman seized of lands in fee-simple, or fee-tail, *i. e.* of any estate of inheritance, and has by her issue born alive, which was capable of her estate, shall, on the death of his wife, hold the lands for his life, as tenant by the curtesy of England.

The English laws are generally esteemed by foreigners as very hard, in respect to the women; and yet Chamberlayne is of a very different opinion, asserting, that the condition of wives in England is better than in any other country.

The disabilities to which the wife is subject are for the most part intended for her protection and benefit. So great a favourite (says judge Blackstone) is the female sex of the laws of England.

Tertullian has two books, on the ornaments and attire of wives. In the second, he labours to prove that a Christian wife cannot, in conscience, endeavour to please by her beauty, which she knows to be naturally liable to raise loose desires; and that she ought not only to avoid all affected beauty, but even to conceal and cover her natural beauty.

WIFE, *Mid, Obstetrix*. See *DELIVERY*.

WIFFLISBURG, in *Geography*. See *AVENCHES*.

WIGAN, a borough and market-town in the hundred of West-Derby, and county of Lancaster, England, is seated near the rise of the river Douglas, the banks of which

are noted for a celebrated battle fought between king Arthur and the Saxons, when the latter were defeated. In the time of Henry VIII., Wigan is described by Leland as a "paved town, as big as Warrington, but better builded, and inhabited by some merchants, artificers, and farmers." In its present state, it has a neat though irregular appearance; and has been lately much improved by the opening of two new streets, and the erection of several handsome buildings. An extensive trade is carried on in the manufacture of coarse home-made linens, checks, calicoes, fustians, and other cotton goods. Here are also large brass and pewter works.

Wigan is a borough by prescription, and has had its privileges confirmed by the several charters of Henry III., Edward II., Edward III., Richard II., and Charles II. Its corporate body consists of a mayor, recorder, twelve aldermen, and two bailiffs. Two members are returned to parliament; and the right of election is vested in the free burghesses, in number about 200. The representation of this borough has occasioned some very expensive contests; and it is said to have cost George Byng, esq. 10,000*l.* in his opposition to the interest of sir Fletcher Norton, and Simon Luttrell, esq. Returns appear so early as the 23d and 35th Edward I., after which the privilege was suffered to be dormant for 240 years; no other return being made till 1st Edward VI.

The parish-church is ancient, and considered to be a handsome structure: it consists of a nave, a spacious chancel, and two side-aisles. Among the monuments in the church is one to the memory of sir Roger Bradshaigh, and another to sir William and lady Mabel Bradshaigh. The remains of George Hole, rector of this church and bishop of Chester, are deposited within the communion-rails. He died August 23, 1668. The rectory is one of the best endowed in the kingdom, and the incumbent is always lord of the manor. In the town is a chapel of ease, three chapels for dissenters, and one for Roman Catholics. A town-hall was built in 1721, at the joint expence of the earl of Barrymore and sir Roger Bradshaigh, the then representatives of the borough. A free-school was erected, and liberally endowed, about the beginning of the last century, by voluntary contribution; and upwards of 30 years ago, the same liberality established a blue-coat school for 30 boys. A commodious workhouse has been also built at the expence of the inhabitants of the town, where the necessitous and superannuated poor are comfortably accommodated; industry in the more able are furnished with the means, and the meritorious are encouraged and rewarded. A dispensary has been erected, and is supported by the benevolence of the inhabitants of the town and its vicinity.

At the north end of the town is a monumental pillar, erected in 1679 by Alexander Rigby, esq., then sheriff of Lancashire, to commemorate the valour and loyalty of sir Thomas Tyldesley, who was slain on this spot in 1651, in the action wherein the earl of Derby was defeated by colonel Lilburne.

In a field near Scholes-bridge, contiguous to this town, a spring was lately discovered, which has obtained the name of *Wigan Spa*, or New Harrowgate, as the water resembles that of Harrowgate in Yorkshire.

The population of Wigan, which has been progressively increasing, was, in the year 1801, according to the return to parliament, 10,989; the number of houses, 2236. In 1811, the former had increased to 14,060, and the latter to 2686.

The parish of Wigan contains twelve townships, in three of which, besides that in the town, are chapels of the establishment,

blishment, subordinate to the mother church. Three of these townships, Haigh, Afpinall, and Hindley, are worthy of notice for the production of the finest cannel or candle coal, which is found in large blocks as black as jet, and will bear a beautiful polish. (See *COAL, Cannel.*) The Liverpool and Leeds canal, and the river Douglas, afford navigable communication between this town and several other towns. On an eminence in this township, about a mile north of Wigan, is Haigh-hall, the ancient seat of the Bradshaighs, a family of high antiquity and distinction, but now extinct; from whom it descended by marriage to the earl of Balcarras, who now resides here. This venerable mansion was built at different periods; the chapel is supposed to be coeval with the reign of Edward II. In the vicinity of Wigan originally stood the ancient family mansion of the Marklands.

Four miles west of Wigan is the village of Holland, or Up-Holland, whence the illustrious but ill-fated family of Holland derived their name.

About three miles north of Wigan is the village of Blackrode, at which place the Rev. John Whitaker fixes the Roman station, named Coccium. Mr. Percival and Mr. Watson both agree with Mr. Whitaker in placing Coccium here; but these opinions are satisfactorily refuted by the historian of Whalley, who contends that this ancient station was at Ribchester.—*Beauties of England and Wales*, vol. ix. Lancashire, by J. Britton, F.S.A.

WIGEON PENELOPE, *Anas Penelope* of Linnæus, in *Ornithology*, is a well-known bird. (See *DUCK.*) Its bill is lead-coloured, and the end of it black; the head, and upper part of the neck, of a bright light bay; the forehead paler, in some almost white; the plumage of the back, and sides under the wings, are elegantly marked with narrow black and white undulated lines; the breast is of a purplish hue, sometimes, though rarely, marked with round black spots; the belly white; and the vent-feathers black. In some birds the coverts of the wings are almost wholly white; in others of a pale brown, edged with white; the greater quill-feathers are dusky; the outmost webs of the middle feathers of a fine green, the tips black; the last are elegantly striped with black and white; the two middle feathers of the tail are longer than the others, black, and sharp pointed; the rest ash-coloured; the legs dusky.

The head of the female is of a rusty brown, spotted with black; the back is of a deep brown, edged with a paler; the tips of the lesser quill-feathers white; the belly white. Pennant.

WIGGER, in *Geography*, a river of Switzerland, which runs into the Aar, 3 miles N.W. of Zoffingen.

WIGHT, ISLE OF. See *ISLE of Wight*.

WIGHT, *Isle of*, a county of Virginia, on the right side of James river, about 40 miles long and 15 broad, watered by the Nansemond. It contains 9186 inhabitants, including 4041 slaves.

WIGLEN, a small island in the North sea, near the coast of Norway. N. lat. 65°.

WIGSTADT, a town of Bohemia, in the circle of Koniggratz; 6 miles N.E. of Geyersberg.

WIGSTADTEL, or **WAKOW**, a town of Silesia, in the principality of Troppau; 10 miles S. of Troppau. N. lat. 49° 38'. E. long. 17° 47'.

WIGTON, a town of Cumberland, England, stands in a fine dry open country; and within the last thirty years has been greatly increased in population, from the introduction of manufactures. In the year 1811 its inhabitants amounted to 2977, who occupied 643 houses.

The first manufactories established here were for different kinds of coarse linens; but since the year 1785, this business has received a considerable check by the encouragement given to the various branches of the cotton trade, which flourish in great vigour. In 1790 a manufactory for printing calicoes was established at Spittle, about a quarter of a mile from the town, and seems likely to become an important undertaking, as the goods are in high repute, and the situation extremely convenient for extending the works.

The present church was erected in 1788: its neatness is eminently contrasted with the ancient fabric, which was a dark gloomy structure, built, according to the Chronicon Cumbriæ, by Odoard de Logiz, to whom the barony was given by Waldeof, son of earl Gospatrick. The materials it was constructed with were procured from the Roman station at Old Carlisle, as appears from the stones being marked in a similar manner to those that may yet be obtained there. In removing the foundations of the old tower, two Roman sepulchral inscriptions were discovered. The streets are tolerably spacious, and many of the buildings are handsome and modern. In the year 1723, an hospital was founded here, under the will of the Rev. John Thomlinson, A.M. for six indigent widows of Protestant beneficed clergymen, episcopally ordained; and incorporated by the name of "The Governesses and Sisters of the College of Matrons, or Hospital of Christ in Wigton." The endowment has been augmented by some small benefactions: the allowance to each widow is about eight pounds annually. A free-school was also established here in 1780; chiefly by the contributions of the inhabitants, aided by the benevolence of Dr. Thomlinson's brother. In this town, observes Mr. Gough, was anciently an hospital or free chapel, dedicated to St. Leonard, to which, Mr. Pegge is of opinion, belongs a seal found in Pickering-castle, Yorkshire: it is of wood, and has the representation of the Deity, with the crucifix, circumscribed *Sigillum Wigton*.

About one mile south from Wigton are the ruins of the considerable Roman station, now called Old Carlisle, but generally supposed to have been the Olenacum of the Notitia, where the Ala Herculea were in garrison. Vestiges of ancient buildings are very conspicuous; the foundations of numerous ruined edifices being scattered over many acres, as well within the vallum as on every side, without excepting to the westward, where the ground descends precipitously to the brook Wifa. The station itself occupied an elevated site, and commanded an extensive view north and north-west. Its form is an oblong square 170 paces in length and 110 broad, with obtuse angles, defended by a double ditch and vallum, and having an entrance near the middle of each side. The military way, on which it stands, is very broad and distinct, and leads immediately to Carlisle and the Wall. Within the vallum, a well was discovered a few years ago, about three feet in diameter, and regularly lined with stones. Various inscriptions, sacrificing instruments, coins, altars, small images, statues on horseback, urns, and other vestiges of antiquity, have been found at this station.

Several antiquities, discovered near this place in the course of the last century, have been described in different volumes of the Gentleman's Magazine, particularly in those for the years 1748, 1756, and 1757.

Clea-hall, a seat of sir Henry Fletcher, bart., whose family obtained it by an intermarriage with the female heir of a branch of the Musgraves, stands on a cultivated spot in the midst of an elevated and dreary moor.—*Beauties of England and Wales*, vol. iv. Cumberland, by J. Britton and E.W. Brayley.

WIGTOWN, a royal borough, market-town, and the capital of the shire of the same name, Scotland, is situated on the side of a hill near the confluence of the river Bladenock, at the distance of 105 miles S.W. by S. from Edinburgh. It is of very high antiquity, and appears to have received its charter of incorporation from king Robert Bruce. The civil government is vested in a provost, two baillies, and twelve counsellors. Wigtown unites with the boroughs of Whitehorn, New Galloway, and Stranraer, in sending one member to the British parliament. The church is in good repair. A well-supplied market is held weekly, and five fairs annually. Being the shire-town, the sheriffs' courts are holden here. A grammar-school is established, and well conducted. The parish of Wigtown is in the form of an oblong-square, extending five miles in length and four in breadth, and comprehends about 5500 acres. The climate is cold, but remarkable for producing health and longevity. A great diversity prevails in the soil and surface: towards the south it is interspersed with hills, which are almost entirely arable, with a dry, light, and fertile mould; the north-west corner is more varied and less productive; and the north-west part is principally covered with moss, and appears to have been formerly an arm of the sea. The greater part is inclosed; and the spirit of agricultural improvement is much encouraged. Particular attention is paid to the repairs of the roads and bridges. The population of the parish, at the enumeration of the year 1811, amounted to 1711. In the western part of the parish is a large circle of stones, called "The Standing Stones of Torhouse," which is supposed to have been a temple of the Druids.—*Beauties of Scotland*, vol. ii. Wigtownshire. *Gazetteer of Scotland*, 1806. *Carlisle's Topographical Dictionary of Scotland*, 2 vols. 4to. 1813.

WIGTOWN Bay, a bay of the Irish sea, on the S. coast of Scotland, at the mouth of the river Cree, between the counties of Wigtown and Kircudbright.

WIGTOWNSHIRE, the western part of the district of Galloway, forms the south-western extremity of Scotland. It is bounded on the E. by Kircudbright, on the S.E. by Wigtown bay, on the S. and W. by the Irish sea, and on the N. by Ayrshire. It is of an irregular figure, of which the greatest length is about thirty miles, and the breadth nearly twelve. The superficial contents are 469 square miles, or 238,721 Scottish acres. The shire comprehends three royal boroughs, Wigtown, Stranraer, and Whitehorn; also the town of Portpatrick, and thirteen other parishes. By the population return of the year 1811, the number of houses is stated to be 5402; that of the inhabitants 26,891; namely, 12,205 males, and 14,686 females. The shire sends one member to the imperial parliament, and the three boroughs unite to send another. Wigtownshire is one of the most level counties in Scotland; and the hills are in general free from projecting rocks, and very accessible to the plough. The navigation along the coast is so uninterrupted, that it may be regarded as one of the most eligible situations in the island, in point of natural advantages, for a trading district. The richest lands lie upon the coast, where the means of improvement are to be met with in the greatest abundance: the inland and more elevated parts have a considerable mixture of heath and moss, but are all in a greater or less degree susceptible of improvement. There are few mountains in Wigtownshire. The Cairnpat, near Portpatrick, is one of the most considerable: it rises 800 feet above the level of the sea. The summit bears all the marks of having been a military station, being surrounded by three stone walls, with very ample spaces between them;

and commands a prospect of Loch-ryan, and Luce bay, which by advancing inland form the peninsula, called the Rhynns of Galloway, in which Portpatrick is situated.

The rivers of this county are of no great importance. The Cree forms part of its eastern boundary. The next stream to the westward is the Bladenoch, which rises from a lake called Loch Macbeary, situated mostly between the two parishes of Kirkowen and Penningham. There are several small islands in it; upon the largest of which are the remains of a considerable building and small garden. The river Bladenoch, which has its source in this lake, runs in a south-easterly direction for about two-thirds of its length; after which it takes a more easterly course, and empties itself into the bay of Wigtown: its whole length is about twenty-four miles. Tarff is a stream which rises in the precincts of Ayrshire, and after a course of twelve miles, in a south-easterly direction, falls into the Bladenoch in the parish of Kirkowen. Luce-water is a small river, which runs into the great bay of that name. Salmon are caught in it; and it is observed that the skin of the salmon, when it first goes up the river, which is deeply tinged with moss, is of a silvery colour, but after remaining some time, it becomes of a brownish-yellow.

Wigtownshire has several fresh-water lakes, but none of particular importance. In the parish of Sorbie is one of three miles in circumference, well stored with pike, perch, and eels. It is called Dowalton lake, because the ancient powerful chiefs, the Macdowals, had their residence near it. In the parish of Ince are fifteen lakes, of different degrees of extent, abounding with fish of several kinds, and frequented by a variety of water-fowls. Swans emigrate from Ireland, particularly in severe winters, and continue in these lakes till spring. The shire of Wigtown is deeply penetrated by navigable bays. Wigtown bay and Luce bay advance in a direction nearly parallel far into the country towards the north. At the same time, from the northern part of the county, the long and narrow bay called Loch-ryan advances southward towards the bay of Luce, and peninsulates an extensive territory, which appears to have long remained divided from the rest of Scotland. Loch-ryan is a beautiful as well as a safe and commodious bay for shipping. It is about ten miles in length from north to south: the entrance into it is nearly two miles broad. It is bounded on the east by the parish of Balantrae, in Ayrshire, and on the west by Millar Point, a headland in the parish of Kirkholm. About three or four miles from the mouth of the loch, on the east side, is the little village of Cairn; contiguous to which is a commodious bay with good anchoring ground, and depth of water sufficient for ships of any burthen; and all vessels entering into or coming out of the frith of Clyde seek this bay in stormy weather. King William's fleet anchored here in their passage to Ireland. Besides the Cairn bay, there are several other good anchoring bays in the loch. Luce bay, which advances from the south towards Loch-ryan, is far more extensive. In dark and hazy weather, vessels often mistake Luce bay for the Irish channel, and when keeping a northerly course, sometimes run on shore, before the error is discovered. The bay of Luce contains a great variety of lesser bays, some of which are capable of being converted into convenient harbours; and mariners acquainted with them find anchoring places, in which they are in safety from almost every wind. The coast around the bay of Luce is very various: in some places it consists of a fine gravel beach; at other points steep rocks project into the sea, forming a bold inaccessible shore. The most southern point of the coast, or rather of Scotland, is called the Mull
of

of Galloway: in the western side of it rises a very elevated coast: it is about the extent of a mile, and projects itself as the boundary between the Irish sea and the bay of Luce. In a high westerly wind a prodigious swell of sea rolls round the point, and is then awfully grand. Here the sea has formed caverns, which are rendered dreadful by a setting-in tide and a strong westerly wind. The noise is like loud claps of thunder. Ships pass and repass this point from England, Ireland, and the west of Scotland.

Though the *agriculture* of this county is yet but in an inferior state, great exertions are making to bring the soil under the best management of which it is capable. Still, however, the defects of the soil, added to the imperfect state of the husbandry which has hitherto existed, greatly depress the value of the territory. The earl of Stair's estate is said to extend to about 55,000 acres, but produces an annual rental of no more than 11,000*l.* sterling. There are in this county great tracts of flow moss, of that soft consistence which renders it almost inaccessible, and of no utility either for agriculture or pasturage. Little hopes are yet entertained of the practicability of improving this sort of territory. But it is confidently asserted, that an immense field of moss of this description below Newton Douglas might by proper management be floated into the sea, leaving some thousand acres of rich clay behind. The great trunks of trees that are found in the mosses of this county, afford full proof of its having been formerly covered with wood. The renewal of the forests, however, proves a very arduous task; and in certain exposures on the coast has repeatedly baffled the hopes of the most ingenious and attentive planters. Wood, corn, and potatoes, in this exposure, are more or less injured, according to their vicinity to the sea; whereas, when protected from it, they are found to grow with their usual vigour. Shelter, therefore, either natural or artificial, must be had on this coast before wood can be planted with any chance of success. Scottish firs, which serve to nurse up plantations in many other parts of the country, are unfortunately found to thrive worse here than any other species of wood. Under this difficulty, the earl of Galloway fortunately discovered the valuable properties of the pinaster, or maritime pine, which he observed to grow with a degree of luxuriance superior to any other in his plantations. He has since increased the propagation of that tree, and now finds that under its protection, almost any other wood may be planted with success. Attempts are making to introduce dairy-farms into this county, for the purpose of supplanting the universal practice of breeding cattle. One farmer, upon this plan, has no less than eighty milking cows: he uses his whole milk in the manufacture of cheese, which he exports to the Clyde. A remarkable breed of small white-faced sheep, peculiar to the coast of this county, deserves notice. It is called the Mochrum breed. These are said to be of Spanish extraction, an idea the more readily adopted, from the quality of their wool, which is of the fine clothing sort, of a texture superior to most in Scotland, and but little inferior to real Spanish. This breed, which is at present of an under size, is well-shaped, hardy, and found by proper attention to improve much, both in weight of carcase and wool.

The mineral productions of the county are but few: the parish of Kirkmaiden, which forms the southern part of the peninsula that bounds the bay of Luce on the west, contains valuable quarries of slate, of which considerable quantities are wrought and sent to market. Here are several natural caverns, in one of which is a petrifying water, dropping from the roof. In the parish of Inch, situated

upon Loch-ryan, are several mineral springs: one, with a sulphurous impregnation, has been found useful in stomachic and scorbutic complaints. There is also a chalybeate spring. Some appearances of coal have been thought to exist here; but that valuable mineral has hitherto been sought in vain. In this quarter, towards Ayrshire, is a bold rocky shore, containing several natural excavations or caverns, extending eighty or an hundred yards under ground. The parish of Whitehorn, in the south-eastern part of the county, produces very fine variegated marble, and also slate of a strong quality. The chief natural defect incidental to this county is the want of coal, a defect common to it with almost the whole of the southern border of Scotland. Was it not for this check to the establishment of manufactures, it might be likely to assume some share of commercial importance. Though of small extent, it has an ample sea-coast, which affords great facility for exporting the produce of its agriculture and dairies. This facility is so great, that the inhabitants of Wigtownshire are sometimes in dread of scarcity, in consequence of the greater part of their produce being carried to Glasgow, Paisley, or Liverpool, where a market is always to be obtained.—*Beauties of Scotland*, vol. ii. Wigtownshire, 1805. *Gazetteer of Scotland*, 1806.

WIGWORM POINT, a cape on the coast of Patagonia, in the straits of Magellan; 3 miles N.E. of Cape Providence.

WIHACS, or WIHATS. See BIHACS.

WIHENAIS, a town of Sweden, in the province of Savolax; 40 miles N. of Christina.

WIHR, or WEYER, a town of France, in the department of the Upper Rhine; 6 miles W. of Colmar.

WIHRBACH, a river of France, which runs into the Rhine, 7 miles above Germerheim.

WIKES, in *Agriculture*, a term used to signify temporary boundaries or marks, set up in order to divide the swaths to be mown; such as the boughs of trees, in the common fields and meadows in different districts; as well as such boughs when set upon hay-cocks and stouks of corn for the taking of tithes, and other such purposes.

WIKINISH CREEK, in *Geography*, a river of Pennsylvania, which runs into the Susquehanna, N. lat. 40° 32'. W. long. 77° 1'.

WILAUF, a river of Wurtemberg, which runs into the Rens, near Schorndorf.

WILBASSEN, or WILBADESSEN, a town of Westphalia, in the bishopric of Paderborn; 8 miles S.E. of Dringenberg.

WILBRAHAM, a township of Massachusetts, in the county of Hampshire, with 1776 inhabitants; 10 miles E. of Springfield.

WILBURG, a citadel of Austria; 8 miles E.S.E. of Ips.

WILBYE, JOHN, in *Biography*, one of our best madrigalists of queen Elizabeth's reign. In his first set, the following are well-known: "Lady, when I behold the roses sprouting;" and "Flora gave me fairest flowers:" but, "Hard by a crystal fountain," which, according to Hearne, (*Lib. Nig. Scacc.*) used annually to be sung by the fellows of New college, Oxon, we are unable to find. Those words are adjusted to the music of Giov. Croce, in the second book of *Musica Transalpina*, and are set by Morley in the *Triumphs of Oriana*; but appear not either in the first or second set of Madrigals published by Wilbye, and we know of no other.

WILD ALBEN, in *Geography*, a mountain of the duchy of Stiria; 7 miles N.N.W. of Muertzenschlag.

WILD *Angelica, Basil, Briar, Campion, Carline Thistle, Carrot, Chervil, Cistly, Climber, Lettuce, Liquorice, Madder, Marjoram, Melic, Mint, Mustard, Oat, Radish, Rape, Rocket, Tare, Thyme, and Vine, in Agriculture.* See WEED.

WILD-Fire, or *Erysipelas*, a disease in sheep, which affects the skin, and which, if not well attended to, is liable to spread very quickly among the flock. It is attended with considerable inflammation in many cases, though but seldom with blisters over the body. It commonly takes place towards the latter end of summer, and does not continue more than eight days at a time, although such sheep as are once affected with it are very liable to have it again. It was formerly a practice with shepherds to bury the sheep that were affected with this disease in the ground at the door of the fold, with their feet upwards, which, they believed, acted as a charm to drive it from the flock. But this folly is now done away with.

In the cure of this affection of the skin, recourse may be had to evacuations from the bowels by the use of calomel, or purging-salts, dissolved in warm water, for three or four days; then sulphur with nitre may be given in pretty full doses, cooling washes being used at the same time. Strengthening remedies should afterwards be employed, such as oak, or other barks of the same nature. During the cure, the sheep should be kept from being too much exposed to cold, and in a dry sound pasture, being well fed when necessary.

WILD-Fire, *Ignis Gregalis, or Gracus.* See WILD-FIRE.

WILD-Fire Arrows, such as were trimmed with wild-fire, and shot burning, to stick in the sails or rigging of ships in a fight. See FIRE-ARROW.

WILD-Fowl. See WATER-FOWL, and DECOY.

WILD-Goose, *Anas Anser.* See DUCK.

WILD-Goose Chase. See CHASE.

WILD-Honey. See HONEY.

WILD-Land, *Reclaiming of, in Agriculture.* See RECLAIMING LANDS.

WILD-Olive. See ELÆAGNUS.

WILD Service-Tree, in *Agriculture and Gardening*, a deciduous tree of considerable growth, which is much cultivated in the field and pleasure-ground. It has been observed, that this tree is sometimes planted in orchard-grounds among fruit-trees, but that it should be put in pleasure-grounds, plantations, or on lawns, for its ornamental effect in the autumnal season.

If trained up with straight clean stems, service-trees will grow to the height of thirty or forty feet; in that case, they should be planted among forest-trees, or in the back parts of large shrubberies. But those who wish to plant them as flowering shrubs must head them down when young, to make them throw out horizontal shoots; they may then be planted among the middling-sized shrubs, which will make a beautiful variety, both when in flower, and when bearing fruit. These trees grow to a considerable size when properly managed, and are very much used by wheelers and others, on account of the wood being all, what they call, heart-wood.

The fruit has been found excellent for feeding game, and other sorts of birds and fowls.

WILDAU, in *Geography*, a town of the duchy of Stiria, on the west side of the Muehr; 12 miles S. of Gratz.

WILDBAD, a town of Wurtemberg, celebrated for its warm-baths; 30 miles N.E. of Strasburg. N. lat. 48° 40'. E. long. 8° 26'.

WILDBERG, a town of Wurtemberg, on the Nagold; 3 miles N. of Nagold. N. lat. 48° 33'. E. long. 8° 48'.—Also, a town of Prussia, in the province of Oberland; 12 miles S. of Ortelburg.

WILDBERG, or *Wildbergen*, a town of the Middle Mark of Brandenburg; 28 miles N. of Brandenburg. N. lat. 52° 55'. E. long. 12° 38'.

WILDE, JAMES, in *Biography*, a Swedish historian, was born in Courland in 1679, and educated at Riga; and having quitted that city in 1695, he sought farther improvement in several German academies, graduating M.A. at Griefswald. At the age of 21, such was his proficiency in various branches of literature, he was appointed co-rector of the cathedral school at Riga, and soon after teacher of politics, history, and eloquence, in the royal gymnasium of that place. Qualified by his talents and acquirements for a higher rank in the department of instruction, he was invited, in 1703, to be professor of history in the academy of Pernau; but declining this office, he was, in the following year, nominated by Charles XII. to fill the chair of Latin eloquence and poetry, which he occupied for five years. During his stay at Aix-la-Chapelle, which he visited in 1709 for the recovery of his health, the Russians made an irruption into Livonia, and he lost his library, with all his documents and papers. From hence, instead of returning to his native country, he proceeded to Stockholm, and offered his services to the senate. Such were the existing troubles at that time, that it was not till the year 1713 that government appointed him to be professor of eloquence and poetry at Griefswald. But he preferred a humble and more private situation as tutor to the two sons of count Cronhielm, with whom he made a tour to England, Holland, France, and Germany. Pursuing a similar tour with a young Holstein count, and becoming acquainted with the duke of Holstein, he was appointed his cabinet-secretary, in connection with the professorship of the law of nature and nations at Kiel. And in the same year king Frederick made him historiographer to the kingdom; on which office he entered at Stockholm in November 1719. His works were numerous and learned; but his constitution was feeble, so that he sunk under his labours, and died in 1755. Although he was more than thirty years old when he went to Sweden, he obtained a thorough acquaintance with the Swedish history: he was also well acquainted with the public law of Germany; and in his earlier years he had raised himself by writing Latin poetry. He was also a good philosopher, and a theologian, and often preached. His memory was singularly retentive; and this served him in various works which he composed after having lost his sight in 1741. Many of his works were lost at the capture of Pernau. During his tour with the sons of count Cronhielm, he published at Frankfurt, in 1717, “*Diatriba de Jure et Judice Legatorum á Stephano Cassio;*” *Sueciæ Historia Pragmatica, quæ vulgo jus publicum dicitur, &c.*” Holm. 1731, 4to.; “*The Foundation, Nature, Origin, and Antiquity of the Swedish Laws, with an Account of the Changes and Alterations which have been made in them,*” *ibid.* 1736, 4to.; “*Puffendorf’s Introduction to the History of Sweden, with Additions, Proofs, and Notes,*” by J. Wilde; “*I. Part,*” *ibid.* 1738, 4to.; “*II. Part,*” *ibid.* 1743, 4to.; “*Preparatio hodegetica ad Introductionem Puffendorffii in Svethici status Historiam, &c.*” *ibid.* 1743, 4to. Gen. Biog.

WILDE, in *Geography*, a river of Prussian Lithuania, which runs into the Ruffe.

WILDE.

WILDEBERG, a town of Pomerelia; 2 miles S. of Marienburg.

WILDEMAN, a town of Westphalia, in the principality of Grubenhagen, near which are some mines of silver and lead; 6 miles S.W. of Goslar.

WILDENBERG, or WILDENBORG, a town of the duchy of Berg; 10 miles E. of Homberg.

WILDENBERG, a town and castle of France, in the department of the Rhine and Moselle; 10 miles W. of Kirn.

WILDENBRUCH, a town of Hinder Pomerania; 5 miles S. of Balm.

WILDENECK, a town of the duchy of Carniola; 10 miles S.E. of Stein.

WILDENFELS, a town of Saxony, in the circle of Erzgebirg; 5 miles S.E. of Zwickau.—Also, a citadel in the territory of Nuremberg; 3 miles W.S.W. of Bezenstein.

WILDENFURT, a town of Saxony, in the circle of Neustadt; 2 miles N.N.E. of Weyda.

WILDENHOF, a town of Prussia, in Natangen; 23 miles S. of Brandenburg.

WILDENS, JOHN, in *Biography*, was born at Antwerp in 1584. He became an admired painter of landscapes, but under whom he acquired the art is unknown. He appears to have been a diligent observer of nature, and to have studied much in the open air; as his studies of forests, fields, &c. are numerous. When he had obtained considerable reputation, his talents introduced him to the notice of Rubens, who employed him to assist in executing the landscape parts of back-grounds, which he did with so great felicity, that there appears no dissimilarity in styles in the pictures on which they both took their respective parts. Two of his best pictures are in the chapel of St. Joseph at Antwerp, embellished with figures by Lang Jan: the subject of one is the Flight into Egypt, and of the other a repose. He died in 1644, aged 60.

WILDENSCHWERT, in *Geography*, a town of Bohemia, in the circle of Chrudim; 9 miles E. of Hohenmaut.

WILDENSTEIN, a town of Germany, in the margravate of Anspach; 7 miles S.E. of Creilheim.

WILDENTHAL, a town of Saxony, in the circle of Erzgebirg; 7 miles S.S.W. of Schwartzenberg.

WILDERNESS, in *Gardening*. There is nothing so great an ornament to a large garden as a wilderness, when properly contrived, and judiciously planted.

The wilderness should always be proportioned to the size of the garden, and should never be situated too near the house: because the trees perspire so large a quantity of watery vapours, as makes the air very unwholesome: though vegetables serve, as modern experiments have sufficiently ascertained, to purify and meliorate the air. See AIR.

The wilderness should never be so placed as to block up a good prospect; but where the view naturally ends with the verge of the garden, or little more, nothing terminates it so well as a fine plantation of trees. The size of the trees should be considered, and tall growing ones should be planted in larger places; smaller, in less extensive; ever-greens also should be kept by themselves, and placed most in sight, not mingled confusedly among the trees which cast their leaves. The walks should be large and not numerous; the large walk is best made serpentine, and this should not be entered upon in the grand walks of the garden, but by some private walk.

It is too common a method to dispose the trees in wildernesses, in form of regular squares, triangles, &c. but this

is faulty; for as nature should be studied in these works of fancy, the most irregular is the most pleasing plantation. The walks for the same reason are much more pleasing when they run in wild meanders, than when they intersect one another in studied and regular angles. The winding walks should be made to lead to an open circular piece of grass, with a statue, an obelisk, or a fountain: or, if an opening large enough for a banqueting-house be contrived in the middle, it will afford a very pleasing scene. The trees should gradually rise from the sides of the walks and openings, one above another, to the middle of the quarters, where the largest trees should stand, by which means the heads of all the trees will appear in view, but their stems will not appear in sight.

Not only the growth of trees is to be considered in the planting of a wilderness, but their nakednesses are to be considered and hid. The larger growing trees are allowed a proportionable distance, and their stems hid by honey-suckles, roses, spiræas, and other low-flowering shrubs. These may also be planted next all the walks and openings; and at the foot of these, near the walks, may be set rows of primroses, violets, and daffodils, with other the like flowers; behind the first rank of lower flowering shrubs should be planted those of a somewhat higher stature, as the *althæa-frutices*, the cytifuses and guelder-roses; and behind these may be rows of the tallest flowering shrubs, as the lilacs, laburnums, and the like; and behind these, the heads only of the lower growing trees will appear, which should be backed gradually with those of higher growth to the centre of the quarter; from whence the heads of the trees should descend every way to the walks, or openings. The grand walks and openings should always be laid with turf, and kept well mowed; but, beside these, there ought to be smaller serpentine walks through the several quarters, where persons may retire for privacy; these should be left with the bare earth, only kept clear of weeds, and laid smooth.

These walks should be made as winding as possible, and a few wood-flowers planted along their sides will have a very good effect. The ever-greens should be allotted a peculiar part of the wilderness, and such as fronts the house; and in the planting of these, the same regard is to be had to their growth, that the tallest trees be planted hindmost, and their stems hid by shorter ones, and so on, down to the verge: as in the first row may be planted laurustines, boxes, spurge, laurels, junipers, and favins; behind these, laurels, hollies, and arbutuses; next behind these, yews, alaternusses, phillereys, cypresses, and Virginian cedars; behind these, Norway and silver firs, and the true pine; and finally, behind these, the Scotch pine and pinaster. These will have a very beautiful appearance, as their tops will only be seen, and make a sheet of green, which may also be very beautifully varied, from the artful admixtures of the several shades of green which the various plants have.

In all these plantations, the trees, however, should not be set in formal stiff rows, but in a loose variety, proportioned to their manner of growth. Miller.

WILDERSDÖRF, in *Geography*, a town of Austria, on the Zeya; 8 miles W.S.W. of Zisterdorf.

WILDESHAUSEN, a town of Westphalia, with a district formerly belonging to the archbishopric and duchy of Bremen, and afterwards to the duchy of Brunswick, in which it is insulated. It is situated on the Hunte, and contains about 312 houses. The inhabitants are partly Roman Catholics; in the bailiwick are 30 villages; 20 miles S.S.W. of Bremen. N. lat. 52° 52'. E. long. 8° 27'.

WILDING, in *Rural Economy*, a four austere sort of apple, often used with others that correct these qualities, for making home cyder. See **CYDER**.

WILDING, *Royal*, an excellent cyder-apple. It is said, in the Gloucester Report on Agriculture, to be a native of Dimock; that it is a free, clean, and handsome grower; makes excellent cyder, is a great favourite among the planters in the upper part of the forest-district of that county, and is much introduced in the vale, on the east side of the Severn. See **CYDER**.

WILDS, a term used by our farmers to express that part of a plough by which the whole is drawn forwards.

The wilds are of iron, and are of the form of a gallows, whence they are by some called the gallows of the plough, but improperly; the gallows of the plough being properly that part formed by the crow-staves, and the transverse piece into which they are mortised at the top. The wilds consist of two legs, and a transverse top-piece: one of the legs, and the top-piece, are all of one piece of iron; and the other leg, which is loose, has a hole in the top, into which the end of the transverse piece is received: both these legs pass through the box of the plough, which is that transverse timber through which the spindles of the wheels run. These legs are pinned in behind the box with iron pins: the holes through the box at which these legs pass, are not made at right angles, but slanting upwards, so that the forepart of the wilds is higher than the hinder part; were it not for this, the upper part of the crow-staves would lean quite back when the plough is drawn.

The use of the notches in the wilds is to give the plough a broader or narrower furrow; if the links are moved to the notches on the right-hand, it brings the wheels toward the left, which gives the greater furrow; and, on the contrary, a smaller furrow is made when the links are moved to the notches on the left. The legs of the wilds should be nineteen inches, and their distance eight inches and a half; they must be made strong, and the links must be placed in different notches, that the front of the plough may be kept steady, and the wheels not be drawn one before the other. These links are of iron also, and are each six inches and a half long, and to these are fastened the chains of the harness, by which the whole plough is drawn along.

WILDSAUBACH, in *Geography*, a river of Germany, which runs into the Elbe, 6 miles below Dresden.

WILDSEE, a lake of the duchy of Stiria; 8 miles E. of Neumarck.

WILDSHUT, a town and castle of Bavaria; 5 miles N.N.W. of Lauffen.

WILDSTADT. See **WILLSTADT**.

WILDUNGEN, a town of Germany, in the county of Waldeck; 7 miles S.S.E. of Waldeck. N. lat. $51^{\circ} 7'$. E. long. $9^{\circ} 8'$.

WILEHNGEN, a town of Switzerland; 9 miles W. of Schaffhausen.

WILEIA, a town of Samogitia, on the Niemen; 25 miles S.S.E. of Rosienne.

WILF, in *Agriculture*, a term used provincially to signify the white willow. See **WILLOW**.

WILFERSDORF, in *Geography*, a town of Austria; 4 miles W. of Brugg.

WILHELMSDORF, a town of Prussia, in Oberland; 13 miles S. of Holland.

WILHELMSHOF, a town of Germany, in the duchy of Anhalt Bernburg, near Hartzgerode.

WILHELMPURG, a town of Austria; 8 miles S. of St. Polten.

WILHELMSTEIN, a town of France, in the department of the Roer; 7 miles S.W. of Juliers.

WILHELMSTHAL, or **NEUSTADTEL**, a mine-town of Silesia, in the principality of Glatz; 15 miles S.E. of Glatz. N. lat. $50^{\circ} 3'$. E. long. $16^{\circ} 42'$.

WILIA, a river of Lithuania, which runs into the Niemen, near Kowno, in the palatinate of Troki.

WILINGO, a town of Sweden, in the province of Schonen; 7 miles N. of Helsingborg.

WILITZ, a town of Bohemia, in the circle of Kaurzim; 5 miles N.N.W. of Kaurzim.

WILKES, **JOHN**, in *Biography*, was born in London in 1727, and finished his studies at the university of Leyden. Soon after his return to England, he married a Miss Mead, who was a lady of large fortune, and settled at Aylesbury. This lady, though highly respectable both in her character and connections, and belonging to a dissenting family as well as himself, was older than he, and in other respects an unsuitable wife, so that the attachment was originally formed, on his part, from lucrative motives: one daughter was the fruit of this connection. Mr. Wilkes, thus furnished with the means of profusion, lived in an expensive style, and being little anxious about domestic happiness, associated with the gay and licentious, to whose habits and manners his principles and character were sacrificed. Urged by his partial friends who thought him qualified for public life, he offered himself, in 1754, as a candidate for the town of Berwick, but his views were disappointed. In this and in several other instances, he counteracted the inclinations and wishes of his wife, so that their continued connection was a source of disquietude, and they determined to separate. In 1757 he was returned as a member for the borough of Aylesbury, the consequence of which was an increase of expenditure, that involved him in pecuniary embarrassments, and led him to dishonourable practices, and particularly to an attempt of freeing himself from the obligation of paying his wife's annuity, in which he failed of success. His parliamentary patron was earl Temple, by whose influence he was chosen representative for Aylesbury; and from whose interest he expected to obtain some place under government, which the perplexity of his circumstances rendered particularly desirable. But he was once and again disappointed; and he ascribed his failure to the interference of lord Bute. In 1762 he connected himself, as a political writer, with lord Temple and Mr. Pitt, and defended them, whilst he exposed the ministry, on occasion of the rupture with Spain, in a pamphlet entitled "Observations on the Papers relative to the Rupture with Spain." This publication was followed in 1763 by an ironical dedication to lord Bute, of Ben Jonson's "Fall of Mortimer," in which he indulged unrestrained levity against the "favourite," as he was called, and his antipathy to the Scottish nation; which was further manifested in a periodical paper called "the North Briton," commenced in 1762, and intended to counteract "the Briton," which Smollet conducted in defence of lord Bute's administration. The North Briton, however, was written with a spirit so consonant to the sentiments of the public at that period, that it probably contributed to the resignation of that nobleman in April 1763. The 45th number of this periodical work was published on the 23d of April, and contained so severe and sarcastic a comment on the king's speech, that his ministers, under the sanction of the crown-lawyers, determined upon a prosecution: and the home secretary of state, lord Halifax, issued a "general warrant;" i. e. a warrant, in which no particular names were specified, for the apprehension of the authors, printers, and publishers of that paper. As soon as it was discovered that Wilkes

had given orders for the printing, he was taken into custody, and brought before the two secretaries of state. Perfectly self-possessed, and avowing the illegality of his arrest, he refused to answer any interrogatories; and a habeas corpus which had been sued out for him being evaded, he was closely confined in the Tower. However, he was soon after brought by habeas corpus before the court of common pleas, when lord chief justice Pratt declared the opinion of that court against the legality of his commitment, so that he was discharged amidst the acclamations of the audience and of the populace. In the course of these proceedings he was deprived of his commission as colonel, by the king's order; and his patron, lord Temple, lost his post of lord-lieutenant of the county. This nobleman, at his own expence, availed himself of the legal decision against general warrants, and commenced actions against the king's messengers, the secretaries, the under secretary, and the solicitor of the treasury; in all which the prosecutors obtained damages, which were paid by the crown, in consequence of an express order of council. Thus the doctrine of the illegality of such warrants was established, and for this accession to the cause of liberty the public were indebted to John Wilkes, lord Temple, and lord chief justice Pratt, afterwards lord Camden. Wilkes, not satisfied with this triumph, proceeded, against the advice of friends, to set up a press in his own house, and to reprint the *North Briton*; for which he was again prosecuted to conviction. Having withdrawn to France in 1763, he was expelled from the house of commons, because he did not appear to answer the charges that were produced against him. The next attack that was directed against him was occasioned by his printing an indecent and profane piece, called "*Essay on Woman*," and said to have been written by Mr. Potter, son of the archbishop of the same name; and as some scandalous reflexions on a bishop were introduced in this piece, complaint of breach of privilege was made in the house of lords; and on a prosecution, he was found guilty of both the crimes of blasphemy and libel. By his continued absence, he incurred the penalty of outlawry. Upon a change of ministry he returned to England, and delivered himself to custody; and confiding in his popularity, he offered himself as a candidate to represent the city of London; but failing in this object, he was immediately elected for the county of Middlesex. Although his sentence of outlawry was reversed as illegal, he was condemned for his two libels to an imprisonment of 22 months, and a fine of 1000*l.* In 1769 he was charged with being the author of a pamphlet relating to the riots, occasioned by his imprisonment, and expelled from the house; and being immediately re-elected, he was declared incapable of a seat in the house during the existing parliament. He now became popular as the martyr of liberty, and large sums were collected towards the payment of his debts. He was again re-elected, and his election was declared void. At the next election, the court-candidate, colonel Luttrell, whose votes were about a fourth of those of Mr. Wilkes, was declared the fitting member. This measure caused dissatisfaction and complaint through the country, and produced petitions for the dissolution of parliament. Wilkes, though excluded from parliament, was chosen an alderman of the city of London; and in the exercise of his office as a magistrate, he resisted with his usual spirit exactions of authority which he considered as illegal; and actually liberated one of the printers of newspapers in which the speeches of members of parliament were detailed, and who had been arrested by royal proclamation. Two others were released by lord mayor Crosby and alderman Oliver, who being members of the house were committed to the Tower. Wilkes

was ordered to attend at the bar of the house; but in a letter to the speaker, he objected, that in the order for attendance, no notice was taken of his being a member of the house, and his attendance in his place had not been desired, which forms, he said, were essential: he also demanded his seat, and then he would give a full account and justification of his conduct. The house, sensible of the difficulty to which it had subjected itself, saved its authority by adjourning for the day on which Wilkes was ordered to attend. In 1772 Wilkes was chosen one of the sheriffs for London and Middlesex, and in 1774 lord mayor of London. Having conducted himself with propriety and reputation in his public offices, he was re-elected in 1776 a representative for the county of Middlesex; and was allowed to take his seat without opposition. In parliament, he opposed the measures that occasioned the American war; and on the accession of the Rockingham administration, he carried his motion for rescinding the decision of the house of commons, which gave Luttrell a seat by a minority of votes. In 1779 he succeeded in his application for the office of chamberlain in the city of London, and retained it during the remainder of his life. Tired of political conflicts, the latter years of his life passed off without much notice, so that, to adopt his own expression, he was an "extinguished volcano;" and he expired at the house of his daughter in 1797, in the 73d year of his age. His private history affords no memorial that is either amusing or instructive. The early errors of his conduct cast a shade over his character. His literary talents and attainments, devoted as he was to pleasure, and engaged in business, never attracted much notice; though as a companion he knew how to render himself agreeable. Although his patriotism might possibly originate in disappointed views and expectations, he was consistent and steady in maintaining the cause to which he was attached; and he was, either intentionally or incidentally, and by an intrepidity and self-possession which he possessed in an eminent degree, the instrument of gaining some important advantages to public and private liberty. *Alm. Mem. of Wilkes. Ann. Reg. Gen. Biog.*

WILKES, in *Geography*, a town of Ohio, in Gallia county, with 187 inhabitants.—Also, a county of the state of Georgia, bordering on South Carolina, containing 7066 inhabitants. Tobacco is the chief produce, of which 3000 hogheads were exported in 1788.—Also, a county in the N.W. corner of North Carolina, with 7247 inhabitants, including 790 slaves.—Also, a town of North Carolina; 50 miles W. of Salem.

WILKESBARRE, formerly WYOMING, called also *Wilkesburg*, a town of Pennsylvania, and chief town of Luzerne county; situated on a plain, bounded on one side by the Susquehanna, and on the other by a range of mountains, and containing about 150 wooden dwelling-houses, a church, court-house, and gaol, with 1225 inhabitants. A dreadful massacre was committed in this place, during the American war, by the Indians under the command of colonel Butler, which is recorded in most histories of that war, and which will ever remain a blot on the English annals. Several of the houses, to which the unfortunate victims retired to defend themselves on being refused quarter, are still standing, perforated in every part with balls; the remains of others that were set on fire are also still to be seen, nor will the inhabitants on any account suffer them to be repaired. N. lat. 45° 13'. W. long. 75° 50'. *Weld's Travels*, vol. ii.

WILKINS, DAVID, in *Biography*, a learned antiquary, was born in 1685, and in early life more than once made the tour of Europe, acquiring a knowledge of most modern languages. In 1715 he was appointed by archbishop Wake

keeper of the Lambeth library, of which he made a catalogue, and for his three years' labour in this way he was recompensed with several preferments, such as the rectories of Hadley and Monk's Ely, the archdeaconry of Suffolk, and a canonry of Canterbury. Among his principal publications we may reckon "Novum Testamentum Copticum," Oxon, 1716, 4to.; an edition of "Leges Saxonicae ecclesiasticae et civiles," with many valuable additions, 1721, fol.; "Joannis Seldeni Opera omnia," 1726, 3 vols. fol.; "Pentateuchus Copticus," 1731, 4to.; "Concilia Magnae Britanniae," 4 vols. fol. 1736; and a learned preface to bishop Tanner's "Britannico-Hibernica." He married the eldest daughter of Thomas, lord Fairfax, settled in Scotland, and died in 1745, in his 60th year. Nichols's Lit. Anecd. Gen. Biog.

WILKINS, JOHN, D.D., an English prelate, was born near Daventry, in Northamptonshire, in 1624, and finished his education at Magdalen-hall, Oxford, where he graduated M.A. He afterwards took orders, and became chaplain, first to lord Say, and then to Charles, count palatine of the Rhine. At the commencement of the civil war he joined the parliament, took the solemn league and covenant, and became warden of Wadham college. In 1649 he graduated D.D., and in 1656 married the sister of Oliver Cromwell. In 1659 he was nominated head of Trinity college, Cambridge; but being ejected on the restoration of king Charles II., he became preacher to the society of Gray's-Inn, London, and rector of St. Lawrence, Jewry; about which time he was introduced into the Royal Society as fellow and one of the council, and advanced to the see of Chester. He was distinguished by his moderation, and was reproached on this account by his enemies, who represented him as wavering in his religious principles. Several bishops censured him with uncandid severity, among whom were archbishop Sheldon, bishop Fell, and archbishop Dolben, making no allowance for the favourable disposition which he was led to manifest towards the dissenters by his education under Mr. John Dod, his grandfather, a truly pious and learned man, who disapproved many things in the church of England long before the grand separation which took place on account of Laud's impositions and severities. After the Restoration he was a moderate conformist, and disposed to be indulgent in many things, for the sake of preventing religious dissensions. On this account he incurred hatred and obloquy. He at length fell a victim to the stone, occasioned by his sedentary habits, and close application to study; and died, with a tranquillity and firmness becoming a wise man and a Christian, at the house of his friend Dr. Tillotson, in Chancery-lane, London, in November, 1672. Bishop Wilkins was not only an able divine, but a good mathematician and astronomer; and well skilled in mechanics and experimental philosophy. As a writer he was judicious and plain; and he studied more to be useful than to please. Generous in his disposition, he neither sought honour nor riches. The revenues which he received from the church he spent in its service; and whilst he was secure from want, he did not wish to be richer. His character is thus delineated by Dr. Burnet: "He was a man of as great a mind, as true a judgment, as eminent virtues, and of as good a soul, as any he ever knew; and though he married Cromwell's sister, yet he made no other use of that alliance but to do good offices, and to cover the university of Oxford from the frowns of Owen and Goodwin. At Cambridge he joined with those who studied to propagate better thoughts, to take men off from being in parties, or from narrow notions, from superstitious conceits, and fierceness about opinions. He was also a great observer and promoter of experimental philoso-

phy, which was then a new thing, and much looked after. He was naturally ambitious, but was the wisest clergyman I ever knew. He was a lover of mankind, and delighted in doing good." He also possessed, according to this historian, "a courage which could stand against a current, and against all the reproaches with which ill-natured clergymen studied to reproach him." His principal works are the following: viz. "The Discovery of a New World; or, a Discourse tending to prove that it is probable there may be another habitable World in the Moon," London, 1638, 4to., written when he was only twenty-four years of age; "Discourse concerning the Possibility of a Passage to the World in the Moon;" "Discourse concerning a new Planet, tending to prove that it is probable our Earth is one of the Planets," *ibid.* 1640, 8vo.; "Mercury; or, the Secret Messenger; shewing how a man may with privacy and speed communicate his thoughts to a friend at any distance," *ibid.* 1641, 8vo.; "Mathematical Magic; or, the Wonders that may be performed by Mechanical Geometry," in two books, *ibid.* 1648 and 1680, 8vo. These latter five, composing his mathematical works, were printed at London in one volume, 8vo. 1708. "Essay towards a real Character and a philosophical Language," *ibid.* 1668, fol.; "Of the Principles and Duties of Natural Religion," two books, *ibid.* 1675, 8vo. published by Dr. Tillotson. Also, "Sermons preached on several Occasions," and some others. Life prefixed to his Philosophical and Mathematical Works.

WILKINSON, in *Geography*, a county of Georgia, with 2154 inhabitants, including 318 slaves.—Also, a county of the Mississippi, with 5068 inhabitants, including 2630 slaves.

WILKOMIERS, a town of Lithuania, in the palatinate of Wilna, on the Swienta, near its union with the Wilna; 44 miles N.N.W. of Wilna.

WILKS, a county of North Carolina, with 9054 inhabitants.

WILKUSCHKE, a town of Prussia; 5 miles N.N.E. of Ragnitz.

WILL, VOLUNTAS, is usually defined a faculty of the mind, by which it embraces or rejects any thing represented to it, as good or evil, by the judgment.

Others will have it to be the mind itself, considered as embracing or refusing; adding, that as the understanding is nothing else but the soul, considered as *perceiving*; so the will is nothing else but the soul, considered as *willing*, &c.

Mr. Locke more intelligibly defines the will, a faculty which the soul has of beginning or forbearing, continuing or ending, several actions of the mind, and motions of the body, barely by a thought or preference of the mind, ordering, or as it were commanding, the doing, or not doing, such and such a particular action. This power which the mind has, to order the consideration of any idea, or the forbearing to consider it; or to prefer the motion of any part of the body to its rest, and *vice versa*, is what we call the will. See POWER.

The actual exercise of that power, is what we call *volition*, or willing; and the doing or forbearing of any action consequent on such order of the mind, is called *voluntary*. So far, according to this writer, as a man has a power to think or not to think, to move or not to move, according to the preference or direction of his own mind, so far he is free: and hence liberty, he says, is not an idea belonging to volition or preferring, but to the person having the power of doing, or forbearing to do, as the mind shall choose or direct. On the other hand, wherever any performance or forbearance is not equally in a man's power; wherever doing or not doing

will not equally follow upon the preference of his mind; there he is not free, though perhaps the action may be voluntary. Accordingly, where thought is wholly wanting, or the power to act or forbear according to the direction of thought, there necessity takes place; this, in an agent capable of volition, when the beginning or continuation of any action is contrary to the preference of his mind, is called *compulsion*: when the hindering or stopping of any action is contrary to his volition, it is called *restraint*. Agents that have no thought, no volition at all, are in every respect necessary agents.

Father Malebranche lays it down, that the will is that to the soul, which motion is to the body; and argues, that as the Author of nature is the universal cause of all the motions in matter, so he is of all the inclinations in the mind; and that as all motions are direct, unless their course be diverted and changed by some foreign cause; so all inclinations are right, and could have no other end but the enjoyment of truth and goodness, were there not some foreign cause to determine the natural impression to evil ends.

Accordingly, he defines will to be the impression, or natural motion, which carries us towards good indeterminately, and in the general; and the power the mind has, to direct this general impression towards any particular object that pleases it, is what he calls *liberty*.

Aristotle distinguishes two kinds of acts of the will, *viz.* βουλευσις, *willing, volition*; and προαιρεσις, *election*. The first, that employed about the ultimate end; the latter, about the means.

The schoolmen also distinguish the actions of the will into *elicit* and *commanded*. Elicit acts, *actiones elicite*, are those immediately produced by the will, and really inherent in it; such are *willing* and *nilling*. Commanded acts, *actiones imperate*, are effects produced by other powers; *v. gr.* the sensitive, intellectual, or locomotive powers, at the command or instigation of the will. As to *follow, stay, fight, fly, &c.*

But others will have the former kind properly to belong to the understanding; and only the latter to the will.

The word will is taken in three senses:

1. For the power or faculty of willing, in which sense it is, we have considered it above.
2. For the act or exercise of this power; as, when we say, No man wills his own destruction.
3. For a habit, or a constant disposition and inclination to do any thing. In which sense justice is defined a constant will to give every one what belongs to him: "Justitia est constans et perpetua voluntas jus suum unicuique tribuendi." Instit. Justin.

WILL, *Antecedent*. See ANTECEDENT.

WILL, *Free*. See LIBERTY, and FREEDOM.

WILL, *Last Will, or Testament, in Law*, a solemn act, or instrument, by which a person declares his mind and intention as to the disposal of his goods, effects, &c. after his death. See TESTAMENT.

This act or instrument is emphatically styled the will of the deceased, because it directs the disposal of the whole or part of his property, by written or oral instructions properly witnessed and authenticated, according to his pleasure. Some have distinguished between a testament and a will; a will being properly limited to land, and a testament only to chattels, requiring executors, which a will only for land doth not require: so that every testament is a will, but every will is not a testament. However, the words have been commonly used indifferently.

WILLS, *History of*. Wills or testaments, says judge Blackstone, are of very high antiquity. We find them

among the ancient Hebrews: not to mention what Eusebius and others have related of Noah's testament, made in writing, and witnessed under his seal, by which he disposed of the whole world, a more authentic instance of the early use of testaments occurs in the sacred writings (Gen. chap. xlviii.), in which Jacob bequeaths to his son Joseph a portion of his inheritance double to that of his brethren; which will we find executed many hundred years afterwards, when the posterity of Joseph were divided into two distinct tribes, those of Ephraim and Manasseh, and had two several inheritances assigned them; whereas the descendants of each of the other patriarchs formed only a single tribe, and had only one lot of inheritance. Solon was the first legislator that introduced wills into Athens; but in many other parts of Greece they were totally discountenanced. In Rome they were unknown, till the laws of the Twelve Tables were compiled, which first gave the right of bequeathing; and among the northern nations, particularly among the Germans, testaments were not received into use. Hence it appears, that the right of making wills and disposing of property after death, is merely a creature of the civil state, which has permitted it in some countries, and denied it in others, and subjected it to various restrictions and regulations, where the law allows it.

With us in England, this power of bequeathing is coeval with the first rudiments of the law; not indeed, that it extended originally to all a man's personal estate. See RATIONABILI parte bonorum.

It is also sufficiently clear, that, before the Conquest, lands were devisable by will. But, upon the introduction of the military tenures, the restraint of devising lands naturally took place, as a branch of the feudal doctrine of non-alienation without the consent of the lord. By the common law of England since the Conquest, no estate, greater than for term of years, could be disposed of by testament; except only in Kent, and in some ancient burghs, and a few particular manors, where their Saxon immunities by special indulgence subsisted. But when ecclesiastical ingenuity had invented the doctrine of *uses*, as a thing distinct from the land, uses began to be devised very frequently, and the devise of the use could in chancery compel its execution. However, when the statute of uses, *viz.* 27 Hen. VIII. cap. 10. had annexed the possession to the use, these uses, being now the very land itself, became no longer devisable: whereupon the statute of wills was made, *viz.* 32 Hen. VIII. cap. 1. explained by 34 & 35 Hen. VIII. cap. 5. which enacted, that all persons being seized in fee-simple (except feme-coverts, infants, idiots, and persons of nonsane memory) might by will and testament in writing devise to any other person, except to bodies corporate, two-thirds of their lands, tenements, and hereditaments, held in chivalry, and the whole of those held in focage; which now, through the alteration of tenures by the statute of Charles II. 12 Car. II. cap. 25. amounts to the whole of their landed property, except their copyhold tenements. As for copyhold and other customary lands, these are devisable or not, according to the custom of the respective manors. And generally, a devise of copyhold will not pass, without a surrender to the use of the will. In the case of a child or widow, a court of equity, in favour of these, will supply a defect of surrender (2 Vez. 582. 5 Vez. 557.); so also, when there is a general devise of real estate to pay debts, and there is no real estate but copyhold: also where a copyhold is in the hands of trustees, the person for whom the lands are holden in trust may devise the same without surrender. (2 Atk. 38. 1 Vez. 489.) And though the court will supply the defect of a surrender for the benefit of children, yet the rule

doth not extend to grand-children, or to a natural child, and consequently not to any more distant kindred. (2 *Ve.* 582. 1 *Wilson*, 161. 6 *Ve.* 544.) And if a man, seized of copyhold lands, surrenders the same to the use of his will, and executes a will, not attested by any witnesses, yet it shall direct the uses of the surrender: for the clause in the statute, which requires the testator's signing in the presence of three witnesses, is confined only to such estates as pass by the statute of wills of 34 & 35 Henry VIII., which doth not extend to copyhold. (2 *Atk.* 37. 7 *East's Rep.* 299.) See *MORTMAIN*.

By 29 Car. II. cap. 3. any estate *pur auter vie* shall be devisable by a will in writing, signed by the party so devising the same, or by some other person in his presence and by his express directions, attested and subscribed in the presence of the devisor by three or more witnesses; and if no such devise thereof be made, the same shall be chargeable in the hands of the heir, if it shall come to him by reason of a special occupancy, as assets by descent, as in case of lands in fee-simple; and in case there be no special occupant thereof, it shall go to the executors or administrators of the party that had the estate thereof by virtue of the grant, and shall be assets in their hands.

One that hath money to be paid him on a mortgage may devise this money when it comes. *God. O. L.* 391.

And if the feoffee in mortgage, before the day of payment which should be made to him, maketh his executors and die, and his heir entereth into the land as he ought; it seemeth in this case, that the feoffor ought to pay the money at the day appointed to the executors, and not to the heir of the feoffee: but yet the words of the condition may be such, as the payment shall be made to the heir; as if the condition were, that if the feoffor pay to the feoffee or to his heirs such a sum at such a day, there after the death of the feoffee, if he dieth before the day limited, the payment ought to be made to the heir at the day appointed. 1 *Inst.* 209, 210.

And hereby it appeareth, that the executors do more represent the person of the testator, than the heir doth that of the ancestor; for though the executor be not named, yet the law appoints him to receive the money, but so doth not the law appoint the heir to receive the money unless he be named. 1 *Inst.* 209, 210.

A person may devise by his will the right of presenting to the next avoidance, or the inheritance of an advowson. And if such devise be made by the incumbent of the church, the inheritance of the advowson being in him, it is good, though he die incumbent; for though the testament hath no effect but by the death of the testator, yet it hath an inception in his life-time: and so it is, though he appoint by his will who shall be presented by the executors, or that one executor shall present the other, or doth devise that his executors shall grant the advowson to such a man. *Watf. c.* 10.

But where an advowson was devised to the first or other son of B, that should be bred a clergyman and be in holy orders, and if B should have no such son, to C; both devises were holden by the court of common pleas to be void, as depending on too remote a contingency; for the rule of law is, that the contingency on which such an executory devise hinges must take effect within some life in being, or 21 years afterwards; but it was uncertain that the son of B, if he ever should have any, would take, or be able to take orders within 21 years of the death of his father. *Proctor v. the Bishop of Bath and Wells, and others*, 2 *H. Bla.* 358.

If upon articles for a purchase, the purchaser die, having

devised the land before a conveyance executed, the land will pass in equity; for the testator had an equity to recover the land, and the vendor stood trustee for the testator, and as he should appoint, till a conveyance executed. 1 *Chanc. Caf.* 39. 2 *Vern.* 679.

For the vendor of the estate is, from the time of his contract, considered as a trustee for the purchaser; and the vendee, as to the money, is considered as a trustee for the vendor. 1 *Atkyns*, 573.

So if a man covenants to lay out a sum of money in the purchase of lands, generally; and deviseth his real estate before he hath made such a purchase: the money to be laid out will pass to the devisee. *Id.*

But if a man, having made his will, afterwards contracts for the purchase of lands; the lands contracted for will not pass by the will, but descend to the heir at law. *Id.*

But if a good title cannot be made of the lands; as the heir in such case cannot have the lands, so he shall not have the money intended to be laid out. *Id.*

If a man have a lease for ever so many years, determinable upon life or lives, that is, if such or such live so long; this estate may well enough be given and disposed by will, because it is but a chattel. *Went.* 19.

A lease for years may also be devised to A for life, remainder to B. And if the lease be renewable, and A renew, B shall contribute to the fine so partaking of the benefit of the renewal.

If the testator, by his last will and testament, do give or bequeath to another any debt due unto him, or a thing in action belonging unto him, the legacy is good and effectual in the law, and may be recovered in this manner, that is to say, if the testator do make the legatary executor of that particular debt or thing in action bequeathed, then the legatary as executor thereof may commence suit in his own name, and recover the same to his own use, against him by whom it was due; but if the testator do not make the legatary executor of the debt or thing in action bequeathed, then his remedy lieth in the ecclesiastical court, where he may convent the executor, and compel him either to sue for that debt in a court competent, and upon recovery and payment thereof to pay it over to the legatary, or else to make a letter of attorney to the legatary for the recovery of the debt or thing in action bequeathed in the name of the executor to the use of the legatary. *Swin.* 187, 188.

Albeit the testator have no such thing of his own as is bequeathed, yet nevertheless the legacy is good in law; therefore, if the testator do bequeath a horse or a yoke of oxen, the legacy is good in law, though the testator have neither horse nor ox of his own. But who shall make choice, in this case, of the thing so bequeathed, is a question not to be neglected: and the solution is this; that if the words of the devise be directed to the legatary, as if the testator shall thus say, I will that A B shall have a horse, the choice doth belong to the legatary; but if the words be directed to the executor, as if the testator shall thus say, I will that my executor give to A B a horse, the election doth belong to the executor. Provided nevertheless, that to whomsoever the election doth belong, whether to the legatary, or to the executor, they must not be unreasonable in their election, but frame themselves according to the meaning of the testator; otherwise the legatary might make choice of the best horse in the country, and the executor of the worst, contrary to the meaning of the deceased. *Swin.* 188.

If there be two joint-tenants of lands, and one of them deviseth that which to him belongs, and dieth; this is no good devise, and the devisee takes nothing, because the devisee

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will doth not take effect until after the death of the devisor, and then the surviving joint-tenant takes the whole by prior title, to wit, from the first feoffment. Gilbert on Wills, 120.

And although the jointure is severed before the testator's death, yet if the will be made before the severance, it will have no effect; unless there is a republication of the will after the partition. Bur. Mansf. 1496.

So also a man cannot give or bequeath by will any of those goods or chattels which he hath jointly with another: for if he should bequeath his portion thereof to a third person, this bequest is void by the laws of this realm; and the survivor, which had those goods or chattels jointly with another, shall have that portion so bequeathed, notwithstanding the said will. Swin. 189.

But otherwise it is with the tenants in common (God. O. L. 131.) and coparceners. For there is no survivor between coparceners, but the part of each is descendible, and consequently may be devised. (Co. Lit. 185. b.) And a deed of partition is not a revocation of a devise of his moiety by tenant in common. Luther v. Ridley, cited in 3 P. Wms. 169.

By 20 Hen. III. cap. 2. widows may bequeath the crop of their ground, as well of their dowers, as other their lands and tenements; saving to the lords of the fee all such services as be due for their dowers and other tenements. And this is only in affirmance of the common law. (2 Inst. 80.) But by 27 Hen. VIII. cap. 10. a married woman, having a jointure made, shall not have any dowry of the residue of her husband's lands.

By 28 Hen. VIII. cap. 11. if the incumbent before his death hath caused any of his glebe land to be manured and sown, at his proper costs and charges, with any corn or grain; he may make and declare his testament of all the profits of the corn growing upon the said glebe land so manured and sown.

But if the testator is lessee for years, and sows the land a short time before his lease expires, and then dies, before the corn can possibly be ripe within the term, in this case a devise thereof is void, because he himself could not have reaped it after the expiration of the term, if he had lived. Swin. 191.

Not only that thing may be devised or bequeathed by the testator, which is truly extant, or hath an apparent being at the time of the making of the will or death of the testator; but that thing also which is not in *rerum natura*, whilst the testator liveth: therefore, it is lawful for the testator to bequeath the corn which will be sown or grow in such soil after his death, or the lambs which shall come of his flock of sheep the next year, depasturing in such a field. But if there be no such corn growing in that soil, nor any lambs arising out of that flock, then the legacy is destitute of effect; because no such thing is extant at all as was bequeathed. But if the testator devise a certain quantity of grain or number of lambs, as for the purpose, twenty quarters of corn or twenty lambs, and doth will and devise, that the same shall be paid out of the corn which shall grow in such a field, or arise out of his sheep depasturing in such a ground; though not so much or no corn at all there grow, or not any or not so many lambs there arise, yet nevertheless the executor is compellable by law to pay the whole legacies entirely; because the mention of the soil and of the flock was rather by way of demonstration than by way of condition, rather shewing how or by what means the said legacy might be paid, than whether it should be paid at all yea or no. Swin. 186.

Those things which after the death of the testator descend

to the heir of the deceased, and not to his executor, cannot be devised by testament, except in such cases wherein it is lawful to devise the lands, tenements, or hereditaments.

If a man be seized of a house, and possessed of divers heir-looms, that by custom have gone with the house from heir to heir, and by his will deviseth away these heir-looms; this devise is void: for the will taketh effect after his death; and by his death, the heir-looms by ancient custom are vested in the heir, and the law prefers the custom before the devise. And so it is, if the lord ought to have a heriot against his tenant, and the tenant deviseth away all his goods; yet the lord shall have his heriot for the reason aforesaid. 1 Inst. 185.

The testator may devise all goods and chattels which he hath in his own right, but not those which he hath in the right of another as executor. Swin. 185.

An administrator cannot make a testament of those goods which he hath as administrator to any person dying intestate; because he hath not any such goods to his own proper use, but ought therewithal to pay the debts of the dead person, and to distribute the rest according to law. Swin. 189.

The husband cannot devise such goods as his wife hath as being executrix to another, nor such things as are in action, as debts due to her before marriage by obligation or contract, unless he and his wife recover the same during marriage, or that he renew the bonds, and take them in his own name; otherwise after his death they remain to her. 1 Inst. 351.

But the husband may, at any time during the coverture, release a bond given to his wife. And where the husband makes a settlement, the bonds to his wife, being part of her fortune, will notwithstanding his death in the life-time of his wife, before the security be changed, be decreed in equity to his executor; he being considered in that case as a purchaser for a valuable consideration. Cases in the time of L. Talb. 168.

A man may by his will dispose of his chattels and personal estate that he shall for the future acquire, any time after the making his will, to the time of his death. And this is necessary from the reason of the thing; because the chattels and personal estate are in a continual fluctuation; and if the law were not so, it would create very great confusion, or else would render it necessary for a man to make a new will every day. Gilb. 122.

But it is not so with lands, for they are fixed and permanent: and, therefore, if a man maketh his will, and deviseth therein all the lands which he shall have at the time of his death; and after that, he purchaseth lands, and dieth without republication or making a new will; in this case, though his intent to the contrary is very apparent, yet it is a void devise: for a man cannot devise any lands but what he hath at the time of making his will. And this was adjudged upon great deliberation, by Holt chief justice and the court, in the case of Bunker and Cook: and the judgment was affirmed afterwards upon a writ of error in the house of lords, Feb. 24, 1707. Gilb. 122.

But, by Holt chief justice: If he republished his will, in such manner, and with such circumstances, as are necessary to complete execution of an original will; then the purchased lands will pass as by an original will. (11 Mod. 127.) And in truth this seemeth to make it a new will, to all intents and purposes; and not a republication of the old one.

But a codicil, which concerneth only personal legacies, will not amount to a republication of the will, so as to pass lands purchased after the making of the will. 2 Vern. 625.

If a man deviseth all his lands for payment of his debts, and purchaseth lands afterwards: the lord keeper said he would decree a sale, though there were no precedent articles. 2 Cha. Ca. 144.

If a man hath a lease, and disposeth of it specifically by his will; and after surrenders it and takes a new lease, and after dies; the devisee shall not have this last lease, because this was a plain countermand of his will. Goldf. 93.

But in the case of Stirling and Lydiard, Nov. 21, 1744, where a man devised all and singular his leasehold estate, goods, chattels, and personal estate whatsoever, and afterwards renewed a lease; it was held by the lord chancellor Hardwicke clearly, that the leasehold estate passed by the will.

If a man deviseth a term for years, which he hath not at the time of the devise, but purchaseth some time before his death; Holt chief justice doubted whether this would be good. But Mr. Peere Williams says, that notwithstanding the doubt which the court of king's bench seems to have had in that case, it hath been clearly held to pass by such a will. 3 P. Wms. 169.

WILLS, Persons capable of making. Every person hath full power and liberty to make a will, that is not under some special prohibition by law or custom: which prohibitions are principally upon three accounts; for want of sufficient discretion; for want of sufficient liberty and free will; and on account of criminal conduct.

In the first class are to be reckoned infants, under the age of fourteen if males, and twelve if females; which is the rule of the civil law. By statute 34 & 35 Hen. VIII. cap. 5. wills or testaments made of any manors, lands, tenements, or other hereditaments, by any person within the age of twenty-one years, shall not be taken to be good or effectual in law; for until that time, by the common laws of this realm, they are accounted infants. (Swinb. 74.) But by custom in particular places, they may devise lands before the age of twenty-one. (God. O. L. 21. Wentw. 24.) But no custom of any place can be good, to enable a male infant to make any will before he is fourteen years of age. (Law of Exec. 153.) If the testator is not of sufficient discretion, whatever be his age, that will overthrow his testament. Accordingly, madmen, or otherwise *non compos*, idiots or natural fools, persons grown childish by age or distemper, such as have their senses befuddled with drunkenness; all these are incapable, by reason of mental disability, to make any will as long as such disability lasts. To this class may also be referred such persons as are born deaf, blind, and dumb; who, as they have always wanted the common inlets of understanding, are incapable of having *animum testandi*, and their testaments are therefore void. It has been maintained that persons deaf and dumb, who understand what a testament meaneth, and that are desirous of making one, may by signs and tokens declare their testament: and that a blind person may make a nuncupative testament, by declaring his will before a sufficient number of witnesses; and that he may make his testament in writing, provided the same be read before witnesses, and in their presence acknowledged by the testator for his last will. Swinb. 95, 96.

Persons of the second description are by the civil law of various kinds; as prisoners, captives, and the like. But the law of England does not make such persons absolutely intestable; but only leaves it to the discretion of the court to judge, upon the consideration of their peculiar circumstances of duress, whether they could be supposed to have *liberum animum testandi*. With regard to feme-coverts, our laws differ still more materially from the civil. Among the

Romans, a married woman was as capable of bequeathing as a feme-sole. But with us, a married woman is not only utterly incapable of devising lands, being excepted out of the statute of wills, 34 & 35 Hen. VIII. cap. 5. but also she is incapable of making a testament of chattels, without the licence of her husband, who frequently, upon marriage, covenants with her friends to allow her that licence: his assent, therefore, must be given to the particular will in question, without which it will not be a complete testament. Her will, therefore, operates in the nature of an appointment, the execution of which the husband by his bond, agreement, or covenant, is bound to allow. The queen-consort is an exception, for she may dispose of her chattels by will, without the consent of her lord: and any feme-covert may make her will of goods, which were in her possession *in auter droit*, as executrix or administratrix; for these can never be the property of her husband: and if she has any pin-money or separate maintenance, it is said she may dispose of her savings thereof by testament, without the controul of her husband. But if a feme-sole makes her will, and afterwards marries, such subsequent marriage is esteemed a revocation in law, and entirely vacates the will.

Persons of the third class are, first, all traitors and felons, from the time of conviction; for then their goods and chattels, and all such lands, tenements, and hereditaments, as they shall have in their own right, use, or possession, of any estate or inheritance, at the time of such treason committed, or at any time after, are forfeited to the king. The testament before made doth, by reason of the same conviction, become void both in respect of goods, and also in respect of lands, tenements, and hereditaments. But if a person, attainted of treason, obtain the king's pardon, and be thus restored to his former estate, he may make his testament, and his former testament is good. (Swinb. 97.) Neither can a *felo de se* make a will of goods and chattels, for they are forfeited by the act and manner of his death; but he may make a devise of his lands, for they are not subjected to any forfeiture. (3 Inst. 55.) Outlaws also, though only for debt, are incapable of making a will, so long as the outlawry subsists, for during that time their goods and chattels are forfeited; but he that is outlawed in an action personal, may make his testament of lands, for they are not forfeited. (Swinb. 107.) An outlaw in a personal action may in some case make executors; for he may have debts upon contract, which are not forfeited to the king; and those executors may have a writ of error to reverse the outlawry. (Cro. Eliz. 851.) Coke observes, that an excommunication (meaning the greater excommunication) is worse than an outlawry; for if a plaintiff, who is an executor, be outlawed, his outlawry cannot be pleaded to disable him from proceeding in the suit, because it is in the right of another; but if he is excommunicated, it is otherwise, because every man that converses with such a person is excommunicated himself (1 Inst. 134.); that is, after he is denounced excommunicate, and they are admonished not to converse with him. (Ayl. Par. 266.) As for persons guilty of other crimes, short of felony, who are by the civil law precluded from making testaments, (as usurers, libellers, and others of a worse stamp,) by the common law their testaments may be good.

WILL, Nature and Incidents of a. Wills or testaments are divided into two sorts, *viz.* *written* and *verbal* or *nuncupative*: of which the former is committed to writing; the latter depends merely upon oral evidence, being declared by the testator *in extremis* before a sufficient number of witnesses, and afterwards reduced to writing. A codicil is a supplement to a will.

As *nuncupative* wills and codicils are liable to great impositions, and may occasion many perjuries, the statute of frauds, 29 Car. II. cap. 3. hath laid them under many restrictions; except when made by mariners at sea, and soldiers in actual service. As to all other persons, it enacts, 1. That no written will shall be revoked or altered by a subsequent *nuncupative* one, except the same be in the life-time of the testator reduced to writing, and read over to him and approved; and unless the same be proved to have been so done by the oaths of three witnesses at least; who, by 4 & 5 Ann. cap. 16. must be such as are admissible upon trials at common law.

2. That no *nuncupative* will shall be good, where the estate bequeathed exceeds 30*l.*, unless proved by three such witnesses, present at the making of it, and unless they or some of them were specially required to bear witness to it by the testator; and unless it was made in his last sickness, in his own habitation, or where he had previously resided at least ten days, except he be surpris'd with sickness on a journey, or from home, and dies without returning to his dwelling.

3. That no *nuncupative* will shall be proved by the witnesses after six months from the making, unless it were put in writing within six days; nor shall it be proved till fourteen days after the death of the testator, nor till process hath first issued to call in the widow, or next of kin, to contest if they think proper.

As to *written* wills (*viz.* those that concern not the devise of lands), they need not any witness of their publication. A testament of chattels, written in the testator's own hand, though it has neither his name nor seal to it, nor witnesses present at its publication, is good; provided sufficient proof can be had that it is his hand-writing. (Swinb. 353. Gilb. Rep. 260.) And though written in another man's hand, and never signed by the testator, yet if proved to be according to his instructions, and approved by him, it hath been held a good testament of the personal estate. However, it is the safer and more prudent way, and leaves less in the breast of the ecclesiastical judge, if it be signed or sealed by the testator, and published in the presence of witnesses. It is said in 3 Salk. 396. that by the canon law, and also by the common law, two witnesses are requisite to prove a will of goods; for one witness by the civil law, unto which the other laws are conformed in this matter, is as no witness at all. 1 P. Wms. 13.

The statute of frauds and perjuries, 29 Car. II. cap. 3. directs, that all devises of lands and tenements shall not only be in writing, but signed by the testator, or some other person in his presence, and by his express direction; and be subscribed, in his presence, by three or four credible witnesses. In the construction of this statute, it has been adjudged that the testator's name, written with his own hand at the beginning of his will, as, "I John Mills do make this my last will," &c. is a sufficient signing, without any name at the bottom; though the other is the safer way. (3 Lev. 1.) It hath been said, that if the testator only put his seal to the will, without signing it, this is a sufficient signing within the statute; because signing is no more than a mark to distinguish a man's act, and sealing is a sufficient mark to know it to be his will. (Gilb. 93.) Others, however, have held that sealing without signing was not sufficient. (1 Wilson, 313. 2 Vezey, 459.) Signing being only mentioned in the statute, sealing is not necessary. (God. O. L. 5. 1 Wentw. 29.) It has also been determined, that though the witnesses must all see the testator sign, or at least acknowledge the signing, yet they may do it at different times. But they must all subscribe their

names as witnesses in his presence, lest by any possibility they should mistake the instrument. In one case determined by the court of king's bench, the judges would not allow any legatee, nor consequently a creditor, where the legacies and debts were charged on the real estate, to be a competent witness to the devise. This determination occasioned the statute 25 Geo. II. cap. 6. which restored both the competency and credit of such legatees, by declaring void all legacies given to witnesses, and thereby removing all possibility of their interest affecting their testimony. The same statute likewise established the competency of creditors, by directing their testimony to be admitted; but leaving their credit (like that of all other witnesses) to be considered, on a view of all the circumstances, by the court and jury before whom such will shall be contested. And in a much later case, M. 31 Geo. II. the testimony of three witnesses, who were creditors, was held to be sufficiently credible, though the land was charged with the payment of debts. By stat. 29 Car. II. cap. 3. all declarations or creations of trusts or confidences, of any lands, tenements, or hereditaments, shall be manifested and proved by some writing signed by the party who is by law enabled to declare such trust, or by his last will in writing, or else they shall be utterly void, and of none effect. And all grants and assignments of any trust or confidence shall likewise be in writing, signed by the party granting or assigning the same by such last will or devise; or else shall be utterly void, and of none effect.

No testament is of any effect till after the death of the testator; and, therefore, if there be many testaments, the last overthrows all the former; but the republication of a former will revokes one of a later date, and establishes the first again. Although no man can die with two testaments, because the latter doth always infringe the former; yet a man may die with divers codicils, and the latter doth not hinder the former, so long as they be not contrary. (Swinb. 15.) All codicils are part of the will; therefore, a codicil merely for a particular purpose, as to change an executor, and confirming the will in all other respects, does not revive a part of the will revoked by a former codicil. If two testaments be found, and it doth not appear which was the former or latter, both testaments are void; but if two codicils be found, and it cannot be known which was the first or last, and one and the same thing is given to one person in one codicil, and to another person in another codicil, the codicils are not void, but the persons therein named ought to divide the thing betwixt them. Swinb. 15.

If codicils are regularly executed and attested, they may be proved as wills are. So if they are found written by the testator himself, they ought to be taken as part of the will, and to be proved in common form by the oath of the administrator with the will annexed; and in case of opposition, by witnesses to the hand-writing and finding; and it hath been usual to exhibit an affidavit of the hand-writing and finding, before a probate or administration passes even in common form.

But in case of a real estate, a codicil cannot operate, unless it be executed according to the statute. 1 Ark. 426.

By stat. 29 Car. II. cap. 3. no devise in writing of lands, tenements, or hereditaments, or any clause thereof, shall be revocable, otherwise than by some other will or codicil in writing, or other writing declaring the same, or by burning, cancelling, tearing, or obliterating the same by the testator himself, or in his presence, and by his directions and consent; but all devises and bequests of lands and tenements shall remain and continue in force, until the same be burnt, cancelled, torn, or obliterated by the testator, or by his direc-
tions

tions in manner aforesaid, or unless the same be altered by some other will or codicil in writing, or other writing of the deviser, signed in the presence of three or four witnesses declaring the same.

And no will in writing concerning any goods or chattels or personal estate shall be repealed, nor shall any clause, devise, or bequest therein be altered or changed, by any words, or will by word of mouth only, except the same be in the life of the testator committed to writing, and after the writing thereof read unto the testator, and allowed by him, and proved to be so done by three witnesses at the least.

A will which will pass personal estate is not a sufficient revocation of a former will, by which a real estate is devised. Comyns, 451.

Although the statute says, that no will in writing concerning personal estates shall be repealed by word of mouth only, except the words be put into writing, and read to and allowed by the testator, and proved to be so done by three witnesses; yet where a man by will in writing devised the residue of his personal estate to his wife, and she dying, he afterwards by a nuncupative codicil bequeathed to another all that he had given to his wife, this was resolved to be good: for by the death of the wife, the devise of the residue was totally void; and the codicil was no alteration of the former will, but a new will for the residue. 1 Abr. Caf. Eq. 408.

Also, the statute hath not taken away revocations of wills by act of law; as if the testator afterwards make a feoffment, or do any other act inconsistent with the will: but such revocation remains as before the statute. Carth. 81.

If a man devises lands to one and his heirs, and afterwards mortgages the same lands to another for years or in fee; though a mortgage in fee is a total revocation at law, yet in equity it shall be a revocation *pro tanto* only. 1 Abr. Eq. Caf. 410.

And the reason is, because a mortgage is not considered as a conveyance of the estate, but only as a charge upon it; being merely a security, and in the consideration of equity carries only a chattel interest, the creditor gains nothing real, it affords no dower, and goes to executors. Sparrow and Hardcastle, May 6, 1754. 3 Atk. 798.

But if lands be devised to one in fee, and afterwards mortgaged to the same devisee; this is a revocation *in toto*, being inconsistent with the devise: but if the mortgage had been to a stranger; it had been a revocation *quoad* the mortgage only. Prec. Cha. 514.

If a man seised in fee devises it to one in fee or for life, and afterwards makes a lease to another for years; this, even at law, shall not be a revocation but during the years. 1 Roll's Abr. 616.

So if a husband possessed for forty years devises it to his wife, and after leases the land to another for twenty years, and dies; this lease is not any revocation of the whole estate, but only during the twenty years, and the wife shall have the residue by the devise. Id.

But where a man seised of a lease for lives devised it, and afterward surrendered the old lease, and took a new one to him and his heirs for three lives; it was decreed, that this renewal of the lease was a revocation of the will as to this particular. For by the surrender of the old lease, the testator had put all out of him, had divested himself of the whole interest; so that there being nothing left for the devise to work upon, the will must fall, and the new purchase, being of a freehold descendible, could not pass by a will made before such purchase. 3 P. Wms. 166. 170.

But where the testator devised all and singular his leasehold estate, and afterwards renewed a lease; it was held by

lord Hardwicke clearly, that this leasehold estate passed by the will: for that this is not a specific legacy, but only an enumeration of the several particulars of the personal estate, but yet is a general devise of the whole. 3 Atk. 199.

Though a covenant or articles do not at law revoke a will; yet if entered into for a valuable consideration, amounting in equity to a conveyance, they must consequently be an equitable revocation of a will, or of any writing in nature thereof. 2 P. Wms. 624.

A woman's marriage is alone a revocation of her will. Id.

A man made a will, and appointed one (who was no relation) to be his executor. He afterwards went abroad, where he became a governor of one of the plantations, and sent over for an English woman of his acquaintance, whom he married, and had children by; and died, without an actual revocation of his will. Yet it was determined, that this total alteration of his circumstances was an implied revocation. 1 P. Wms. 304.

It is an established maxim, that wills should be construed favourably. Accordingly, the intention of the testator is called by lord Coke the polar-star, to guide the judges in the exposition of wills. In divers instances, relating to the interpretation of wills, collateral evidence hath been admitted in the court of chancery to explain the testator's intention. But notwithstanding these cases, the courts have been very unwilling to admit of parol evidence in relation to any thing that appears on the face of a will; and it is certain that too much caution cannot well be used in this particular, especially when it is considered that the statute of frauds and perjuries, which was made to prevent perjury, contrariety of evidence, and uncertainty, binds the courts of equity as well as the common-law courts; as also that little regard ought in many cases to be had to the expressions of the testator, either before or after the making his will, because possibly these expressions might be used by him, on purpose to conceal or disguise what he was doing, or to keep the family quiet, or for other secret motives and inducements which cannot after his death be found out. 2 Bac. Abr. 310.

Notwithstanding that wills are generally favoured by the law; yet where the testator endeavours to establish a settlement against the reason and policy of the common law, the judges will reject it. Gilb. 110. 2 Bac. Abr. 79.

Also where the testator by his will maketh no other disposition of his estate than the law itself would have done, had he been silent; there such a will is useless, and shall be rejected: and, therefore, if a devise be made to a person and his heirs, which person is heir at law to the deviser; this is a void devise, and the heir shall take by descent as his better title; for the descent strengthens his title, by taking away the entry of such as may possibly have right to the estate; whereas if he claims by devise, he is in as by purchase. Gilb. 110. 2 Bac. Abr. 79.

Also devises are void and rejected, where the words of the will are so general and uncertain, that the testator's meaning cannot be collected from them; and, therefore, where a man by will gave *all* to his mother, the general words did carry no *lands* to his mother; for since the heir at law hath a plain and uncontroverted title, unless the ancestor disinherits him, it would be severe and unreasonable to set him aside, unless such intention of the testator is evident from the will; for that were to set up and prefer a dark and at best but a doubtful title to a clear and certain one. Gilb. 112. 2 Bac. Abr. 81.

The clause of "perfect mind and memory" is more usual than necessary in a will, and yet not hurtful. (Swinb. 7.)

WILL.

But in case of contell, it is necessary to prove the sanity of the testator. 2 Atk. 56.

For the different modes of devise, and the legal meaning of the appropriate terms by which they are expressed, we refer to Burn's Ecclesiastical Law, *ubi infra*.

From the above accounts it follows, that testaments may be avoided three ways: 1. If made by a person labouring under any of the incapacities before mentioned. 2. By making another testament of a later date. And, 3. By cancelling or revoking it.

The Romans were wont to set aside testaments, as being *inofficiosa*, deficient in natural duty, if they disinherited or totally passed by (without assigning a true and sufficient reason) any of the children of the testator. But if the child had any legacy, though ever so small, it was a proof that the testator had not lost his memory nor his reason, which otherwise the law presumed. Hence probably, says Blackstone, has arisen that groundless vulgar error of the necessity of leaving the heir a shilling or some other express legacy, in order to effectually disinherit him; whereas the law of England, though the heir or next of kin be totally omitted, admits no *querela inofficiosa*, to set aside such testament. Burn's Eccl. Law, vol. iv. art. WILL. Blackst. Com. book ii.

WILLS of Seamen and Marines. By the statute 26 Geo. III. c. 63. no will made by any petty officer or seaman in the king's service, whereby any wages, pay, prize-money, or allowance of money of any kind due for such service is bequeathed, shall be valid, unless, if made while the party is in the service, it be signed before and attested by the captain, or the officer then commanding, and one of the signing officers of the ship to which the party belongs, and unless it specify in the body thereof the name of the ship, and the number at which the maker of the will stands upon the ship's books, and contains a full description of the residence, profession, or business of the person in whose favour it is made, and the day of the month and the place where it was executed, or by the agent of any of his majesty's hospitals or quarters appointed to receive sick and wounded seamen, in which the party may be at the time; or if made by such officer or seaman discharged from the service, within the bills of mortality, unless it be attested by the officer appointed by the treasurer of the navy to inspect such wills; or if made at any of the ports where seamen's wages are paid, unless it be attested by the treasurer of the navy, chief or second clerk there; or if made at any other place, unless it be attested by the minister and churchwardens of the parish in England or Ireland, or by two elders of the parish in Scotland. In order to obtain a probate thereof, the will must be sent to a proctor by the inspector of wills appointed by the treasurer of the navy.

If any such petty officer or seaman should die intestate, the person claiming administration must apply by petition to the said inspector, who is to grant a certificate directed to a proctor, that letters of administration may pass in favour of the petitioner, if entitled thereto by law.

If any proctor, register, or other officer of any ecclesiastical court shall be aiding and assisting in procuring probate of a will, or letters of administration, for the purpose of enabling any person to receive such wages, pay, prize-money, or allowance of money of any kind, without first obtaining the certificate from the inspector of seamen's wills, or person authorized to officiate for him, every such proctor, register, or other officer, shall forfeit 500*l.*, and for ever after be incapable of acting in any capacity in any ecclesiastical court in Great Britain or Ireland.

And by the 32 Geo. III. c. 34. after the 1st day of Au-

gust 1792, no letter of attorney or will of a non-commissioned officer of marines or marine shall be valid unless made according to the 26 Geo. III. c. 63.

All are to be deemed petty officers, seamen, marines, &c. except such as are rated upon the books of such ship, admirals or flag officers, and their secretaries, captains, and lieutenants, masters, second masters, and pilots, physicians, surgeons, chaplains, boatswains, gunners, carpenters, and purifiers, captains of marines, captain lieutenants of marines, lieutenants, and quarter-masters of marines.

Every lieutenant, on board any of his majesty's ships, shall upon a page of every muster book of such ship sign his name for the purpose, and for the purpose only, that the inspector of seamen's wills, or such person as shall be deputed by him, may have an opportunity of comparing the same with the name of any such lieutenant attesting the will, &c. executed by or in favour of any petty officer, seaman, non-commissioned officer of marines or marine.

And all captains of ships shall, upon their monthly muster books or returns, specify which of the men, mentioned in the said returns, have granted or issued any will or testament during that month or space of time from the preceding returns, by inserting the date thereof opposite to the party's name. The muster books, &c. in case of sailing from any foreign station, at a time when no opportunity shall offer of transmitting them to the navy-board, to be left with the naval officer of the place, if any, or with some respectable merchant, with directions to forward the same to the commissioners of his majesty's navy by the first safe opportunity, and in case of the removal of the commander, to be delivered over to his successor and a receipt given for the same.

Provided that it shall be lawful for the minister of any parish, to whom the inspector of seamen's wills shall transmit his check of any letter of attorney or will, passed and allowed by him, to deliver the said check to the attorney or executor in the said letter of attorney or will named and appointed. And all seamen's letters of attorney, and wills made prior to the 1st of August 1786, and those of marines prior to the 1st of August 1792, shall be examined and inspected by the inspector of seamen's wills for the purpose of preventing frauds, forgeries, or impositions of any kind therein; and if such inspector shall see no cause to suspect the authenticity of the same, he shall affix the stamp of his office, and issue checks for the same, but if he shall see good cause to suspect the truth and authenticity of such letter of attorney or will, he shall report the same to the treasurer, or to the paymaster of the navy, and shall enter his caveat against such letter of attorney or will, which shall prevent any money from being paid or received thereon until the same shall be authenticated to the satisfaction of the said treasurer or paymaster.

The wages, pay, prize-money, or allowances of petty officers or seamen, non-commissioned officers of marines, and marines dying intestate, are to be paid only upon letters of administration obtained in the following manner:

The person claiming such administration shall send or give in a note or letter to the inspector of seamen's wills, stating the name of the deceased, the name of the ship or ships to which he belonged, and that he has heard or been informed of his death, and requesting the inspector to give such directions as may enable him to procure letters of administration to the deceased, or to the like effect, upon receipt whereof the inspector of seamen's wills shall deliver or send to the person claiming such administration, a paper in a peculiar form of words, which paper being duly filled up and certified shall be returned to the treasurer, or to the paymaster of his majesty's navy, London, who upon receiving

the same shall direct the inspector of seamen's wills to examine the same, and make such inquiry relative thereto as may appear to him necessary on that behalf; and being satisfied, he shall forthwith make out a certificate for obtaining letters of administration, and pursue the course minutely described in Burn's Ecclesiastical Law, art. *Wills*.

By 32 Geo. III. c. 34. the following sums are to be paid for the seal, parchment, writing, and suing forth of probates of wills and letters of administration granted in pursuance of this act, for the purpose of receiving wages, or pay, or allowances of money of any kind, which shall remain due to the deceased, *viz.*

	£.	s.	d.
For probates of wills, if the goods and chattels are under the value of 20 <i>l.</i> - - - - -	0	15	2
For letters of administration - - - - -	1	4	2
For probates of wills under 40 <i>l.</i> - - - - -	1	8	8
For administration - - - - -	1	17	8
For probates of wills under 60 <i>l.</i> - - - - -	1	11	2
For administration - - - - -	2	8	6
For probates of wills under 100 <i>l.</i> - - - - -	1	13	8
For administration - - - - -	2	11	0
For commissions or requisitions to swear executors or administrators:			
Under 20 <i>l.</i> - - - - -	0	15	0
And under 100 <i>l.</i> - - - - -	1	3	0

But if the probates or letters of administration be granted to the widow, children, father, mother, brother, or sister, in pursuance of this act, for the same purpose of receiving wages, or pay, or allowances of money of any kind, which shall remain due to such warrant or petty officer, &c. then the following sums are to be paid, *viz.*

	£.	s.	d.
For probates of wills under 20 <i>l.</i> - - - - -	0	6	0
For administration - - - - -	0	14	0
For probates of wills under 40 <i>l.</i> - - - - -	0	19	6
For administration - - - - -	1	7	6
For probates of wills under 60 <i>l.</i> - - - - -	1	3	0
For administration - - - - -	1	11	0
For probates of wills under 100 <i>l.</i> - - - - -	1	7	6
For administration - - - - -	1	15	6
For commissions or requisitions to swear executors or administrators:			
Under 20 <i>l.</i> - - - - -	0	12	0
Under 40 <i>l.</i> - - - - -	0	15	6
Under 60 <i>l.</i> - - - - -	0	16	6
Under 100 <i>l.</i> - - - - -	0	18	6

And no more than 5*s.* are to be taken for the suing forth of the probate of any will or letters of administration granted to the widow, children, father, mother, brother, or sister of any such seaman or marine, &c. and 5*s.* for commissions or requisitions to swear such widow, &c. unless the goods amount to 100*l.*: which last-mentioned charge of 5*s.* must be understood to be demandable where the probate or letters of administration are not for the purpose of receiving wages, or pay, or allowances of money remaining due, but for general purposes, as to obtain administration of the goods and chattels of the deceased.

A bill of the expences of obtaining letters of administration to creditors, is to be laid before and taxed by one of the registers of the prerogative court of Canterbury, or their deputies, who are entitled to a fee of 3*s.* 4*d.* for the same; and the proctor is to transmit such letters of administration with the bill of expences so certified, to the treasurer or paymaster of his majesty's navy. Proctors taking more than the prescribed sums forfeit 50*l.*, and registers and

other officers of any ecclesiastical court, procuring letters of administration or probate contrary to this act and the 26 Geo. III., to be incapacitated to act, and forfeit 50*l.*

WILL, Qualification and Office of the Executor of a. See EXECUTOR, EXECUTOR *de son Tort*, and JOINT-Executors. See also DEBTS, DEBTEE-Executor, INVENTORY, and LEGACY.

WILL, Probate of a. See PROBATE.

WILL, Estate at, in Law, is where lands and tenements are let by one man to another, to have and to hold at the will of the lessor; and the tenant by force of this lease obtains possession. Every estate of this kind is at the will of both parties, landlord and tenant: so that either of them may determine his will, and quit his connection with the other at his own pleasure, under certain restrictions. For, if the tenant at will sows his land, and the landlord, before the corn is ripe, or reaped, puts him out, the tenant shall have the emblements, and free ingress and egress to cut and carry away the profits. But where the tenant himself determines the will, the landlord shall have the profits of the land. The law is careful, that no such sudden determination of the will by one party shall tend to the manifest and unforeseen prejudice of the other. This appears in the case of emblements just mentioned; and also, the lessee after the determination of the lessor's will shall have reasonable ingress and egress to fetch away his goods and utensils. And if rent be payable quarterly or half-yearly, and the lessee determines the will, the rent shall be paid to the end of the current quarter or half-year. Upon the same principle, courts of law have of late years inclined as much as possible against construing demises, where no certain term is mentioned, to be tenancies at will: but have rather held them to be tenancies from year to year, so long as both parties please, especially where an annual rent is reserved: in which case they will not suffer either party to determine the tenancy even at the end of the year, without reasonable notice to the other. Blackst. Com. vol. ii.

WILL with a Whisp. See IGNIS Fatuus.

WILL'S Cove, in Geography, a creek on the N.E. coast of the island of St. Christopher, to the S.W. of Muddy Point.

WILL'S Creek, a river of Maryland, which runs into the Potomack, N. lat. 39° 30'. W. long. 78° 47'.

WILLACH. See VILLACH.

WILLAERT, ADRIAN, in Biography, the disciple of John Mouton, and master of Zarlino, has been long placed at the head of the Venetian school of counterpoint by the Italians themselves. He was born at Bruges in Flanders, and during his youth studied the law at Paris; if with the view of making it his profession, there must have been an early conflict between legislation and music, which having a powerful advocate in his own heart gained the cause; for by his own account (see JOSQUIN) he went to Rome in the time of Leo X., where he found that his motet, "Verbum bonum et suave," was performed in the pontifical chapel, as the work of that renowned composer; he therefore must have been a contrapuntist some time, before any of his works could have travelled to Rome.

The account which Zarlino gives of this motet (P. i. p. 175.) having passed for a work of Josquin, excited our curiosity to see it; and finding it among the Motetti della Corona, in the British Museum, we scored it; but discovered that the predilection for a great name had operated too powerfully in favour of this composition while Josquin was imagined to be the author of it; for it is neither written with the clearness, dexterity, nor even correctness, of that wonderful contrapuntist: there is not only confusion in the

the parts and design, in many places, but something very harsh and unpleasing in the harmony, particularly in the closes without a sharp seventh, both in the key-note and in the fifth. The motet is in six parts, soprano, two counter-tenors, tenor, baritone, and base. Some of these sevenths would doubtless have been made sharp in performance by the singers of those times, in obedience to a rule for sharpening ascending sevenths in minor keys, and flattening them in descending.

The list of his works, in Walther's Dictionary, though ample, is far from complete. The motet *Verbum bonum*, just mentioned, was published at Fossombrone in 1519, forty-three years before Zarlino made him an interlocutor in his dialogue (*Ragionamento*), at Venice; and it can hardly be imagined that no others of his compositions appeared till 1542, when, we are told, that his motets for six voices were published. In the *Fior de Motetti*, lib. i. Venice, 1539, there is a *Pater-noster*, in four parts, by Adriano; and in the same year the first book of his motets, for four voices, was republished in the same city by Ant. Gardano, in folio, under the following pompous title: "Famosissimi Adriani Willaert, Chori Divi Marci illustrissimæ Reipublicæ Venetiarum Magistri, Musica Quatuor Vocum (quæ vulgo Motectæ nuncupatur) noviter omni studio, ac diligentia in lucem edita." This edition, which, we find by the title, was not the first, is preserved in the British Museum. Indeed, for near fifty years after his name first appeared, hardly a collection of motets or madrigals was published to which he did not contribute; but the most splendid and curious work of this author, that we have seen, is preserved in the British Museum. It was published at Ferrara, 1558, by his scholar and friend, Francesco Viola, another of the interlocutors in Zarlino's *Ragionamento*, under the title of *Musica Nova*, in three, four, five, six, and seven parts. In the dedication of this work to Alfonso d'Este, duke of Ferrara, the editor, his maestro di capella, calls Adriano (the name by which he is always mentioned by the Italians) his master, and says, that he is strongly attached to him, not only for his wonderful abilities in music, but integrity, learning, and the friendship with which he has long honoured him. Zarlino, in like manner, omits no opportunity of exalting the character of his master. These are honourable testimonies of regard, which seem the more worthy of being recorded, as, either from the worthlessness of the master, or ingratitude of the scholar, they are but seldom bestowed.

In the cantus part there is a wooden cut of the author: "Adrian Willaert Flandrii Effigies." And indeed the compositions are of that kind for which he was most renowned, and such as the editor thought would constitute the most durable monument of his glory. In the tenor part there are many canons of very curious construction; some with two and three clefs, and a different number of flats and sharps for the several parts, which are moving in different keys at the same time; and one particularly curious, in seven parts, "Præter rerum seriem," of which three are in strict canon of the fourth and fifth above the guide; the tenor leading off in G, the sextus following in C, and the septima pars in D, while the rest move in free fugue.

Zarlino (P. iii. p. 268.) assigns to Adriano the invention of pieces for two or more choirs; and Piccitoni (*Guida Armonica*) says, that he was the first who made the bases in compositions of eight parts, move in unisons or octaves; particularly when divided into two choirs, and performed at a distance from each other, as then they had occasion for a powerful guide. The dexterity and resources of this author, in the construction of canons, are truly wonderful, as is, indeed, his total want of melody; for it is scarcely possible to

arrange musical sounds, diatonically, with less air or meaning, in the single parts. But there are many avenues through which a musician may travel to the temple of Fame; and he that pursues the track which the learned have marked out, will perhaps not find it the most circuitous and tedious; at least theorists, who are the most likely to record the adventures of passengers on that road, will be the readiest to give him a cast. A learned and elaborate style conceals the want of genius and invention, more than the free and fanciful productions of the present times.

Adriano lived to a great age, and filled a very high musical station, maestro di capella of St. Mark's church at Venice. His works and scholars were very numerous; and among those to whom he communicated the principles of his art, there were several who afterwards arrived at great eminence; such as Cipriano Rore, Zarlino, and Costanzo Porta. In the title of a book, published at Venice, 1549, there are "Fantasia," or "Ricercari," composed dallo eccellentissimo Adrian Vuigliart, and Cipriano Rore, suo discepolo. P. Martini, in his *Saggio di Contrappunto*, P. ii. p. 266. calls Adrian Willaert the master of Costanzo Porta. Burney.

WILLAFANS, in *Geography*, a town of France, in the department of the Doubs; 3 miles S.E. of Ornans.

WILLAKALA, a town of Sweden, in Finland; 48 miles E. of Biorneborg.

WILLAWAKY, an Indian town on the N.W. coast of lake Michigan. N. lat. 47° 45'. W. long. 87° 10'.

WILLDENOVIA, in *Botany*, received its name from professor Thunberg, in honour of Dr. Charles Lewis Willdenow, late professor of botany at Berlin, well known as the author of many learned botanical writings, but especially by his *Species Plantarum*, of which the immortal work of Linnæus, bearing the same title, is the basis. The addition of essential characters, and of many new species, besides those accumulated in profusion, with great intelligence and discrimination, from authors subsequent to Linnæus, might entitle this to rank as an original work; were not the Linnæan part of it too fervile a transcript, not only of mistakes, of remarks contradicting each other, and of evidently false synonyms; but in general of errors of the press, and wrong citations of plates and pages, which prove that the respective books, though in every body's hands, were not consulted. The learned editor happily lived to complete the first part of the fifth volume, comprising the order of *Filices*, in which he was well verfed. That he left the rest of the *Cryptogamia* unattempted, is perhaps rather fortunate than otherwise. The *Musci*, *Lichenes*, and *Fungi*, each form a study by themselves, and are treated of separately by different authors. They would have added enormously to Willdenow's work, and could, after all, have proved but a compilation. If the science goes on as it has done, an universal botanist will be nearly as impossible a character as an universal naturalist is at present.

Another genus (see *SCHLECHTENDALIA*) was dedicated to Willdenow by Cavanilles, which is retained in Lamarck's *Illustrations*, t. 685, by the name of *Vildenovia*. The change of orthography at the conclusion we readily adopt, instead of the uncouth *Willdenowa*, or *Willdenowia*, and it is now likewise followed by Thunberg himself, in his *Flora Capensis*.—Thunb. in *Stockh. Transf.* for 1790, 28. Prodr. 14. Fl. Capenf. v. 1. 312. Willd. Sp. Pl. v. 4. 717. Poir. in Lamarck Dict. v. 6. 177.—Class and order, *Dioecia Triandria*. (*Triandria Monogynia*; Thunb.)—Nat. Ord. *Tripetaloidæ*, Linn. *Junci*, Juss. *Resiliacæ*, Brown Prodr. v. 1. 243.

Gen. Ch. Male, Cal. Perianth inferior, of numerous, imbricated, membranous, pointed, permanent glumes, longer

than the fruit. *Cor.* Petals six, equal, erect, oval, membranous, permanent. *Stam.* Filaments three, capillary, shorter than the corolla; anthers ovate-oblong.

Female, *Calyx* and *corolla* as in the male. *Pist.* Germen superior, roundish; style very short, two or three-cleft; stigmas two or three, downy. *Peric.* Drupa dry, roundish, smooth. *Seed.* Nut solitary, of one cell.

Eff. Ch. Male, *Calyx* of many imbricated glumes. *Corolla* of six petals, permanent.

Female, *Calyx* and *corolla* as in the male. *Style* one. *Stigmas* two or three. *Drupa* with one seed.

Obs. This genus differs from *RESTIO* (see that article), chiefly in having a single-seeded *drupa* instead of a *capsule*, opening by valves, and containing several seeds. We have here merely altered the phraseology respecting the *calyx*, which in *Restio* is termed, rather improperly, a *catkin*.

1. *W. striata*. Striated Willdenovia. Thunb. in Stockh. Transf. for 1790, 27. t. 2. f. 1. Fl. Cap. v. 1. 312. Willd. n. 1. Poiret n. 3.—Stem leafless, round, striated.—Native of the Cape of Good Hope, as are likewise the two following species. The *stem* is two feet high, or more, erect, rushy, hard and rather shrubby, branched, usually simply forked, rarely three-forked, round, jointed, striated, smooth; the branches also round, striated. *Sheaths* at each joint and subdivision solitary, ovate, close, brown, smooth. *Leaves* none. *Flowers* terminal, solitary, erect, the size of a pea. Scales of the *calyx* about ten, rarely fewer, or more, loosely imbricated, equal, oblong, pointed, brown, smooth, the length of the nail, membranous at the edges. *Corolla* white, much shorter than the *drupa*, and pressed close to its sides. *Style* in two short, broad, yellow divisions. *Stigmas* short, obtuse, brown. *Drupa* ovate, black, dotted; sometimes, according to Thunberg, of two cells, which last circumstance, if real, greatly invalidates the generic character.

2. *W. teres*. Smooth Willdenovia. Thunb. in Stockh. Transf. for 1790, 28. t. 2. f. 2. Fl. Cap. v. 1. 314. Willd. n. 2. Poiret n. 1.—Stem and branches leafless, round, smooth and even. The *stem* of this species is shrubby, much branched, jointed, simply or triply forked, erect, a foot or more in height, not striated; its branches somewhat level-topped. *Sheaths* at each subdivision ovate, brown, smooth, as long as the nail. *Flowers* terminal, solitary, erect. Scales of the *calyx* about six, ovate, awned, grey and smooth. *Petals* very short, emarginate, shining, surrounding the base of the fruit. *Style* undivided, very short. *Stigmas* feathery, tapering, purplish. *Drupa* hard, ovate, black, smooth, of one cell.—This plant differs from the foregoing in having fewer *calyx-scales*, a smooth and more branched *stem*, long tapering *stigmas*, and a smooth, not dotted, fruit. Poiret, who had seen a specimen, attributes to the present species the fleshy cylindrical body, with six notches, surrounding the base of the *corolla* externally, which Willdenow calls a *nectary*, and admits into his generic character. We have seen but few and incomplete specimens of any of the genus, and therefore cannot judge of the part in question, but we presume the term *nectary* must here be misapplied. Thunberg does not mention it in his *Flora*.

3. *W. compressa*. Compressed Willdenovia. Thunb. in Stockh. Transf. for 1790, 28. t. 2. f. 3. Fl. Cap. v. 1. 315. Willd. n. 3. Poiret n. 2.—Stem leafy, smooth and even; branches compressed. *Stem* two feet high, or more, shrubby, erect, smooth in every respect, simply or triply forked; its branches compressed, or semi-cylindrical, wand-like. *Sheaths* of the subdivisions ovate, pointed. *Leaves* on the young branches, and resembling them, thread-shaped, tapering. *Flowers* terminal, solitary, upright, the size of a pea. Scales of the *calyx* ovate, awned, smooth, membranous at

the edges. *Petals* ovate, acute, as long as the fruit. *Style* undivided. *Stigmas* three, feathery. *Drupa* ovate, compressed, obtuse, grey. Thunberg.

WILLEBROD, in *Biography*, the apostle of Friseland, was an Anglo-Saxon, and born in Northumberland about the year 658, and educated in the abbey of Rippon, where he engaged in the religious profession. At the age of 33, he accompanied eleven of his countrymen into Batavia, and employed himself for three or four years in converting the Frisians who were under the French dominion; and having met with great success, he went to Rome, and received from pope Sergius the pallium, ordaining him archbishop of Friseland. Pepin gave him a residence at Wilteburg, now Utrecht, of which he was the first prelate. Embarking from Friseland for the north, he penetrated into Denmark, and in his return was cast by a storm on an island called Fosteland, supposed to be the same with Heligoland. He afterwards baptized Pepin, son of Charles Martel, and spent the rest of his life in propagating Christianity among the Batavians. His colleague and assistant was Winfrid, his countryman, surnamed Boniface, the apostle of Germany. He died in 740, at the age of 82; was buried at his abbey of Eternac, in the diocese of Treves, and honoured with canonization. His life was written by the celebrated Alcuin. Mosheim. Moreri.

WILLEMSTADT, or WILLIAMSTADT, in *Geography*, a strong town of Holland, situated upon that part of the Meuse called Buttermiet, built in 1584, by William I., prince of Orange, from whom it receives its name. This fortress is one of the keys of Holland, and defended with seven bastions and double fosse; it has also a good harbour, but which it is sometimes dangerous for vessels to enter at certain times of the year. It was besieged by the French in the year 1793, but by the brave resistance of the governor and garrison, assisted by the English, with gun-boats, &c. the besiegers were compelled to retire with great loss; 12 miles S.W. of Dort. N. lat. 51° 41'. E. long. 4° 18'.

WILLENBERG, or WILDENBERG, a town of Prussia, in the province of Oberland; 93 miles S. of Königsberg. N. lat. 53° 11'. E. long. 20° 53'.

WILLERING, a town of Austria, on the Danube; 4 miles W. of Lintz.

WILLERSDORF, a town of Bavaria, in the bishopric of Bamberg; 5 miles S.W. of Forcheim.

WILLET'S BAY, a bay on the north-west coast of the island of St. Christopher, about a mile to the south-west of Dieppe Bay.

WILLIAM I., called "the Conqueror," king of England, and duke of Normandy, in *Biography*, was the natural son of Robert, duke of Normandy, by Arlotta, the daughter of a tanner, and born in 1024. When his father went on a pilgrimage to Jerusalem, and his son was only nine years of age, he caused the states of the duchy to swear allegiance to William, as his heir. On his return in 1033, Robert died; and the consequence was a variety of dissensions among the barons of the duchy, in which Henry I. of France took a part; so that when William arrived at majority, he found his dominions in a low and distracted state. But his vigour and exertions soon restored order and submission, and general tranquillity through his duchy. Edward the Confessor, at this time king of England, had no children; and the archbishop of Canterbury, who was a Norman, recommended his adopting William as his successor, and he was commissioned by the king to inform the duke of his intention. However, as he had not publicly divulged his purpose, Harold, the son of earl Godwin, ascended the throne without opposition, on his decease

in 1066. Harold, however, had previously taken a solemn oath to assist William in accomplishing the purpose of Edward respecting the succession; and his perfidy excited the indignation of William, and induced him to prepare for dispossessing Harold of the English throne by force of arms. His intentions were no sooner announced than he was joined by a great number of military adventurers; and upon an appeal to Rome, the pope sanctioned the contest, and sent him a consecrated banner. Thus encouraged, he assembled a fleet of 3000 vessels, and an army of 60,000 men; and determining on invading England, landed on September 28, 1066, at Pevensey, in Suffex. Harold, as soon as he received this intelligence, marched from York, and having recruited his forces at London, hastened to encounter the Normans, who were encamped near Hastings. On the 14th of October the two armies engaged, and after a severe battle, which lasted during a whole day, the English were defeated, with the loss of Harold and his two brothers. William lost no time in availing himself of this victory; but having reduced the town and castle of Dover, and received the submission of the Kentish men, proceeded towards London. In his way he was met by Edgar Atheling, who had been proclaimed legal heir to the monarchy, Stigand, archbishop of Canterbury, and some of the principal nobility, who made an offer to him of the crown; and on Christmas-day, 1066, after a kind of tumultuous election, he was crowned at Westminster-abbey by the archbishop of York, and took the coronation-oath. Having adopted measures for conciliating his subjects, and overawing those who were adverse to him, he re-crossed the sea to Normandy, taking with him as hostages Edgar, the primate, and several of the principal nobility. Soon after his departure, the English were treated contumeliously and oppressively by the Normans, whose conduct excited insurrections, and led to a conspiracy for the massacre of all who remained in the country. This intelligence occasioned William's return in December 1067; and among other measures of a more conciliatory nature, he imprudently renewed the tax called "danegelt," which excited insurrections through various parts of the kingdom. As soon as these insurrections were suppressed, his queen, Matilda, was crowned at Westminster: but new troubles arose from the union of the two principal nobles, Edwin and Morcar, with the kings of Scotland and Denmark, and the prince of North Wales, which threatened an extensive revolt. The conspiracy for this purpose was discovered and crushed, and measures were taken for preventing the evils that were likely to result from it. From this time William's government became daily more and more despotic; and the nobility of the country, perceiving that their ruin was the object of his contemplation, prepared to leave the kingdom. Insurrections broke out in various parts of the country, and the means which he adopted for suppressing them were in the highest degree rigorous and destructive. As a measure of future prevention, he brought from Normandy the feudal constitution into England, and divided most of the lands into baronies, which he granted to the most considerable of his followers, under the condition of certain services and payments; and these subdivided their shares on similar tenures, among others, chiefly foreigners, of inferior rank. The ecclesiastical property of the kingdom was regulated upon a similar system; and under various pretences, the Normans superadded the English in the possession of all church dignities. In order to favour this expulsion of the English dignitaries, a legate from the pope was, for the first time, admitted into this country, and a reverence for the see of Rome, similar to that which subsisted on the continent, was inculcated on all British sub-

jects; whilst the king took care, by reserving certain powers to himself, to guard the civil sovereignty against papal usurpations. In order further to subjugate the minds of the English, and reduce them to the state of a conquered people, the king projected the abolition of their language; and by admitting at court no other language besides the French, he caused all the youth in the schools of the kingdom to be instructed in it, and the laws to be drawn up in that language, which was also used in all judicial pleadings and writings.

Having suppressed an insurrection which broke out in 1071 by the instigation of the earls Edwin and Morcar, and in the following year negotiated a peace with Malcolm, king of Scotland, he was called to Normandy in 1073, on occasion of a revolt in that country. In 1075 his presence was necessary in England to check a conspiracy among the Norman barons, whom he had distinguished by his favour, and who were joined by Waltheof, an English nobleman, on whom he had bestowed his niece Judith. Waltheof, in this conspiracy, fell a sacrifice to the treachery of his wife. In the following year, *viz.* 1076, the haughty and ambitious Hildebrand, who was now pope Gregory VII., required William to do homage for his kingdom to the holy see, alleging a promise to this purpose, and also to pay the accustomed English tribute. William denied his promise of homage, which he refused to render, but remitted to Rome the Peter-pence; and whilst he would not allow the English prelates to attend a general council summoned by Gregory, he permitted the pope's legate to convene a synod at Winchester for establishing the celibacy of the clergy. On his return to Normandy in this year, he found the country engaged in a civil war, in consequence of a rebellion excited by his son Robert. On this occasion the father and son had a personal encounter; but when the son discovered that he was thus engaged, he was struck with horror, fell at his father's feet, and implored forgiveness. The father was at first unrelenting; but they were afterwards reconciled. About the year 1081, William ordered that survey of the landed property of the kingdom to be made which is recorded in Domesday-book. (See DOMESDAY. For an account of the impolitic as well as cruel manner in which he indulged his passion for the chase, we refer to the article FOREST.) The latter years of his life furnished various occasions of affliction and disquietude. The death of his queen Matilda, to whom he was affectionately attached, was an event that took place in 1083, and was the cause of undisssembled sorrow and lamentation. The preparations made by the king of Denmark and the earl of Flanders for an invasion of England occasioned to him no small degree of anxiety: and when he was rescued from this danger by the death of the Danish king, he was called into Normandy in 1086, to repel the incursions of some French barons; and suspecting that the king of France had instigated them to these acts of hostility, he commenced a war against him in 1087, in the prosecution of which he even laid waste the country at the approach of harvest by the most cruel devastation. But an accidental injury which he received in mounting his horse stopped his career, and terminated in his death. Alarmed by the near prospect of dissolution, his mind was harassed with remorse in the review of the atrocious conduct with which he was chargeable, and he sought relief by donations to the church, to which persons of his character have commonly resorted, and by the pardon and release of some of his enemies. By his last testament he bequeathed to his eldest son Robert the counties of Normandy and Maine, and to his second son William, the crown of England, and to his third son, Henry, the property of his mother. He expired at the abbey of St. Gervais, near Rouen,

Rouen, on September 9, 1087, in the 63d year of his age, and the 21st of his reign over England, leaving five daughters, as well as sons. "William the Conqueror at his death," says one of his biographers, "was the most powerful and greatest sovereign of his time. He possessed superior talents, political and martial, and employed them with singular vigour and industry. But his passions were strong, his disposition was severe and merciless, and his ambition and love of rule caused him to disregard all restraints of justice and humanity. There never was a more fortunate usurper of a throne, which he transmitted to a long and still subsisting line of descendants; and the establishment of his dynasty is the most conspicuous era of English history." Rapin. Hume. Henry. Lyttleton. Gen. Biog.

WILLIAM II., surnamed *Rufus*, second son of the Conqueror, and king of England by his father's nomination, was crowned at Westminster in September 1087, and recognized as king when he was about 27 years of age. His brother Robert succeeded to the dukedom of Normandy by the disposition of his father, which proved the occasion of much discontent and contest; partly because the great barons possessed estates both in England and Normandy, and under separate governments; and partly because Robert was the eldest son, and the most popular. A conspiracy was soon formed by the maternal brothers of the late king, in which many nobles concurred for deposing William. But William, possessing a certain portion of his father's vigour, took measures for defeating them. With this view he conciliated the native English, took possession of the castles and persons of the unfortunate barons, banished them to Normandy, and bestowed their estates on his faithful adherents. When he was firmly seated on the throne, he forgot his promises of relieving the English from oppression, and even enhanced the severity of the forest laws. The death of Lanfranc, whom he respected, left him at liberty to seize vacant bishoprics and abbeys, and to bestow church lands on his captains and favourites. In 1090 he visited Normandy with hostile intentions respecting his brother; but a negotiation took place, and they were reconciled. Robert accompanied William to England, and commanded an army which was sent against Malcolm, king of Scotland. But a variance soon took place between the brothers, occasioned by the encroaching and treacherous disposition of William, which led him to excite the Norman barons to rebel against Robert. Whilst William was prosecuting hostile measures against his brother, he was recalled to England in 1095, to suppress a conspiracy among the barons in the north, whom he speedily defeated and severely punished. The spirit of crusading having at this time pervaded Europe, Robert was seized with the mania, and mortgaged his dukedom to William for 10,000 marks, in order to enable him to unite with the crusaders in 1096. William, having gone over to the continent to take possession of Normandy and Maine, was taken extremely ill, and apprehending danger, resolved to repair the injury which he had done to the church, and to supply the vacancy of the archbishopric of Canterbury, which had continued from the death of Lanfranc. The ecclesiastic nominated on this occasion was Anselm, who, notwithstanding the disinclination he had manifested against accepting the appointment, was afterwards a zealous defender of the rights of the church, and of ecclesiastical authority in general. The king and the primate soon disagreed; and though a synod was assembled for the deposition of the archbishop, the king failed in the attempt. But when Anselm desired permission to leave the kingdom, he obtained leave; but his temporalities were seized, and the pope received him as a confessor in the cause of religion.

William's French acquisitions were the occasion of trouble to him; for whilst he was hunting in the New Forest, he received information that the citadel of Maine was besieged, and he therefore hastened to Dartmouth, and determined to embark without delay. As the weather was tempestuous, the mariners expressed some apprehension of danger; the king, however, was resolute and persevering, and asked them if they had ever heard of a king who was drowned. Having accomplished his object, he was applied to by the duke of Guienne, who was under the influence of the passion for crusading, for the loan of a sum of money, as a mortgage on his rich provinces of Guienne and Poitou. William accepted the proposal; but whilst he was preparing to carry over the money, and to take possession of the provinces, he was accidentally killed in the New Forest. Having alighted from his horse after a chase, a stag sprung up near him; and a French gentleman, Walter Tyrrel, perceiving the animal, shot off an arrow, which glancing from a tree, entered the king's breast, and penetrated to the heart. Tyrrel immediately fled, and embarking for France, joined the crusaders. The king's body was found by the country people, and interred without ceremony at Winchester. This happened on August 2, 1100, when the king was in the 40th year of his age, and the 13th of his reign. The character of William Rufus has been unfavourably represented, both on account of the depredations which he committed in the church, and of his indifference to religion. "The incidents of his reign," says a biographer, "prove him to have possessed vigour and decision, courage and policy; but to have been violent, perfidious, and rapacious, and void of all sense of justice and honour. One of his best public acts was the sending Edgar Atheling into Scotland, to restore prince Edgar, son of Malcolm, to the throne of that kingdom, of which he was the lawful heir. He deserves to be regarded as a promoter of the useful arts by his still-remaining erections of the Tower, London-bridge, and Westminster-hall." Gen. Biog.

WILLIAM III., king of England, prince of Orange, and stadtholder of Holland, was the posthumous son of William II., prince of Orange, and of Mary, daughter of Charles I., king of England, and born on November 14, 1650, at a very interesting period. His guardianship was divided between the princess-royal his mother, the princess-dowager his grandmother, and the elector of Brandenburg. During the negotiations that succeeded the naval war between the English and Dutch republics, Cromwell, the protector, stipulated, that the prince of Orange, who was a branch of the house of Stuart, should be for ever excluded from the stadtholderate; but on the event of the Restoration, the princess-royal petitioned, in 1662, that her son might be invested with the offices and dignities which belonged to his ancestors; and soon after the act of exclusion against him was annulled. Although the states of Holland would not admit, as a condition of peace in the succeeding war between England and the United States, the preliminary proposed by Charles II. of elevating the prince to the stadtholderate, they formally adopted him as "a child of the state," and placed him under the care of persons who should inspire him with principles suited to his situation under a free government. After some subsequent debates concerning the rank which should be assigned him, he was raised in 1670 to the dignity of first noble of Zealand, and then admitted into the council of state. On occasion of the war, which was declared by Lewis, and his pensioner Charles, against the United States in 1672, the public voice obliged the magistracy of Holland to revoke the perpetual edict procured by De Witt for abolishing the stadtholderate,

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ate, and to confer that dignity with all its prerogatives upon William. Thus authorized by the States to change the regency in all the most considerable towns of Holland and Zealand, party opposition was extinguished, and every proposal for the defence of the country was unanimously adopted. The prince, at this early age, fully justified the confidence that was reposed in him by the firmness and elevation of his mind. At an extraordinary assembly of the states, he pointed out, in an elaborate speech, the pernicious consequences that must result from the "peace proposed by the French king, who was in possession of three of the provinces; he shewed the possibility of raising supplies for a war in defence of their religion and liberty; and by the cool intrepidity of his manner and force of his arguments, he produced such an effect upon his before-desponding audience, that they concurred in the resolution of making every sacrifice, rather than desert the cause of their country. Vigorous measures were entered upon; foreign alliances were formed; fortunate circumstances prevented the further advance of the French, who evacuated the province of Utrecht; Charles II. was obliged by his parliament to make peace, in 1674, with the Dutch, who in the same year signed separate treaties with the bishop of Munster and the elector of Cologne; and at length the three conquered provinces were re-united to the States General; and the conduct of the prince of Orange so much ingratiated him with the states of Holland, that the offices of stadtholder and captain-general were declared hereditary in his male line." In all his military actions, he displayed both courage and wisdom; so that the prince of Condé testified in his favour, that at the battle of Seneff, "he had in every point acted like an old captain, except in venturing his life too like a young soldier." The humiliation of the French king seems to have been his favourite object; and with this view he wished to fix the English court in the same interest. This was one motive which induced him to connect himself more closely with the royal family, by a marriage with Mary, eldest daughter of the duke of York. Accordingly he came into England in 1678, and then the nuptials took place which were so satisfactory to the nation, and which were afterwards followed by the most important consequences. Without enlarging on the measures pursued by the prince on the continent, we shall direct our attention to those in which our own country was more immediately interested. The succession of the prince's father-in-law to the crown of England in 1685, instead of strengthening the bonds of affinity by which they were attached to one another, served only to separate them more widely. The king was a bigotted papist, and the prince was regarded as a great supporter of the Protestant cause on the continent, and therefore they could not cordially concur in their views and operations. King James, whose object was to render the Catholic religion predominant, began with endeavouring to procure for it a free toleration in Great Britain, by a repeal of the penal laws and the test-act; and in order the more effectually to accomplish his purpose, he strongly solicited the prince of Orange to express his concurrence and that of the princess; but as they knew how unpopular the design was in England, they refused to grant it. About this time Lewis XIV., under the impulse of his own bigotry, and that of those with whom he acted, repealed the edict of Nantes, which had secured the privileges of his Protestant subjects; and by his harsh treatment of them, drove numbers of them out of his dominions, and thus excited a dread and hatred of popery through all Protestant countries of Europe. The effect of this measure with regard to the prince of Orange was, that it sus-

pending all party opposition to him in Holland, and gave him additional importance in Europe, as the determined foe of French ambition. The arbitrary proceedings of king James alarmed all the friends of civil liberty, and of the established religion in England; and apprehensive of danger, they directed their views to the prince of Orange as their deliverer. Accordingly conferences were held with a confidential envoy whom he sent over to ascertain the public opinion; applications were made to the prince by several persons of rank; and at length, when the birth of a prince of Wales disappointed all hopes of a Protestant succession, the leading men of different parties concurred in actually inviting him to come over, and to undertake the protection of the church and constitution from threatening ruin. The prince consented, and with consummate prudence and secrecy prepared for the interesting expedition; and as existing circumstances afforded a prospect of a breach between the United States and their allies, and the king of France, he was thus enabled to augment the Dutch forces by sea and land without suspicion. Having previously dispersed through the kingdom a declaration, stating the grievances of the reign, and announcing his intention of bringing over an armed force to defend the nation from tyranny, and to procure the assembling of a free parliament, he put to sea in October 1688, with a fleet of about 500 vessels, and an army of 14,000 men. He was once driven back by a storm, but a second attempt succeeded, so that he gained the English coast without opposition, (the king's fleet being wind-bound,) and on the 5th of November disembarked his troops at Torbay. Of the causes, progress, and termination of the Revolution, we have given an account under the articles JAMES II. of England, and REVOLUTION. King William seated on the throne became sovereign of a powerful kingdom; but his tranquil possession of the crown depended on a variety of circumstances which he could neither direct nor controul. The conflict of different parties was not easily restrained; nor were his disposition and manners, which were cold and reserved, notwithstanding all his excellent qualities, adapted to unite and conciliate the partisans of the old and new government. Amongst those who had taken an active part in the late measures, or who had acquiesced during their progress, some were dissatisfied with the total exclusion of James and his infant son; and others could not approve the transfer of the crown by the will of the people. In Scotland, the appointment of William was the act merely of the whigs; and in Ireland, where the population was chiefly Catholic, the interest of James was predominant. The church zealots in England were not pleased with the tolerant principles manifested by king William, and with the wishes he expressed for the comprehension of the dissenters. Thus circumstanced, the commencement of his reign was embroiled by the open opposition and secret intrigues of his enemies, and in the progress of it the collision of parties was the occasion of much personal disquietude both to him and to the queen. His attention was for a considerable time distracted by the state of his native country, when war with France was renewed in 1689, by James's invasion of Ireland in the spring of that year, when his interest with the Catholics was powerful, and in which he was aided by the French king, and also by an insurrection of the Jacobite party in Scotland. Ireland seemed at this time to demand his principal exertions; for though marshal Schomberg had been sent over in 1689 to oppose the progress of the late king, little had been done to any important purpose. Accordingly in the summer of 1690, he embarked with a reinforcement for this country, and by the battle of the Boyne, in which Schomberg was killed,

he routed the Irish army, and totally dispersed it. James abandoned the contest, and fled precipitately to France, leaving the reduction of the island to William, which was completely effected in the following year. Whilst he was thus engaged in military operations, a party spirit agitated his domestic government. The convention parliament, consisting of whigs, who were his decided friends, dreaded monarchical power, and refused to settle upon him the crown revenue for life. Hence he was led to dissolve the parliament in disgust; but he soon found that the new parliament, in which the influence of the tories preponderated, though it readily indulged his desires with regard to the revenue, and voted liberal supplies for the Irish war, was composed of persons that were not real friends to the principles which placed him upon the throne. We shall leave to the details of history the events that occurred on the continent in the prosecution of the war against France; and proceed to observe, that in the year 1695 he suffered a severe loss by the death of queen Mary, who had proved herself an affectionate wife, and both faithful and zealous in promoting his interest; nor was his attachment to her less ardent and sincere. The decease of Mary revived the hopes of the Jacobites, and they were busy and active in forming conspiracies, not scrupling to concert the atrocious plan of assassinating the king. In 1697 peace with France was concluded at Ryfwick, and Lewis was reduced to the necessity of acknowledging William as the lawful sovereign of Great Britain, and to make no future attempts for dispossessing him of his throne. The next contest that engaged political parties at home related to the reduction of the military establishment. King William, attached to a military life, and not very confident with respect to his own security on the throne, wished to retain a greater force than parliament was disposed to allow; which was no more than 7000 men, who were to be all natives; so that he was under a necessity, though with great reluctance, of parting with his favourite Dutch guards. The next political object that engaged the king's attention was connected with the balance of power in Europe, and that was the succession to the crown of Spain, upon the death of Charles II., who was in a declining state of health, and who had no issue. In 1701 the king of Spain died, and left a testament in favour of the grandson of Lewis XIV., which will was accepted by the French king; and of course preparations were made by William and the Dutch for renewing the war with France. This measure was further rendered necessary by the death of James II. in the same year, and Lewis's acknowledgment of his son as king of Great Britain. On the meeting of the parliament at the end of this year, William made a speech on the state of affairs, on his own proposed conduct, and on the necessity of mutual confidence between the crown and people. This speech was much applauded, and was answered by a very loyal address. Thus was his reign, which had been distinguished by its vicissitudes and trials, and by the extensive and permanent benefits that resulted from it, drawing to its termination. A fall from his horse gave a shock to his enfeebled constitution, and brought on a fever, the issue of which he tranquilly expected; and he expired on the 8th of March, O.S. 1702, in the 52d year of his age, and 13th of his reign.

The character of king William has been variously delineated by political writers of different sentiments and dispositions. All allow that he possessed considerable political talents, and though in his military operations he was often unsuccessful, few persons exceeded him in his ability for repairing losses, and making a good close of a campaign. Although, as we have before said, his manners were cold

and reserved, he was not destitute of sensibility. The partisans of James, and those who disapproved of the Revolution, have censured his conduct in deposing his father-in-law; but public liberty and the welfare of a nation must be ever regarded as paramount to private duties. He never sought power otherwise than for accomplishing the important and beneficial ends to which his views were directed; and therefore he cannot be justly charged with a culpable degree of ambition. Whatever may be the opinion of erroneous and interested individuals of the Jacobites and tories of more ancient or modern times, "he will ever be gratefully remembered," as one of his biographers says, "by the United Netherlands; as the great founder of their freedom and independence; and will be honoured as the deliverer of the British islands from tyranny, civil and religious, as long as a due sense of the benefits of that deliverance subsists among their inhabitants."

Though the Jacobites in England would not allow that this prince had any music in his soul, Bonnet Bourdelot, in his "*Hist. de la Mus. et de les Effets*," says, "that he had been informed by a friend, one of the attendants of the prince of Orange, afterwards king of England, that in the year 1688, the prince being then at the Hague, and, as may be supposed, deeply engaged in reflexions on the critical situation of his affairs at that time, had three choice musicians to play to him whenever he found himself too much agitated and thoughtful."

WILLIAM of Nassau, prince of Orange, and founder of the Dutch republic, was born in Germany in 1533, and descended from Lutheran parents, though, being introduced into the service of Mary queen of Hungary, and afterwards of Charles V., he conformed to the Catholic religion. He was trained to military and civil employments of high rank; and as he had ample possessions in the Low Countries, he attained to the dignity of governor of the provinces of Holland, Zealand, and Utrecht, under the Spanish government. His character is very highly drawn, and is said to have combined magnanimity, prudence, bravery, equanimity in all fortunes, singular penetration and sagacity, retentive memory, popular eloquence, and the art of conciliating men's affections. Upon the introduction of the inquisition by the bigotry of Philip II., a flame broke out in the Netherlands; and the prince of Orange, with the counts Egmont and Hoorn, did every thing in their power to restrain the severities exercised on a religious account, and to induce the Spanish court to recal cardinal Granvelle, to whose influence solely they were owing; and in this effort they succeeded in 1564. On occasion of the sanguinary measures proposed in the councils of Philip, and carried into execution by the duke of Alva, the prince of Orange, the moderation of whose temper caused him to be suspected, surrendered his employments, and retired with his family, in 1567, to his brother at Nassau. Alva, having arrested counts Egmont and Hoorn, and occasioned them to be condemned and executed, cited the prince of Orange to answer charges of sedition and treason that were preferred against him; and on his non-appearance, his estates were confiscated, and his eldest son, a student at Louvain, was carried off into Spain. William, who about this time seems to have declared himself a Protestant, levied an army with a view of penetrating into Brabant; but Alva's military skill defeated his purpose, and he was under a necessity of disbanding his troops. Still determined on relieving his country, he made another application in 1571 to several Protestant powers for succour, but they were all averse from encountering the power of Spain. At length he obtained from the court of France some supplies of money, and was then enabled to fit out a small squadron, which, in

WILLIAM.

in 1572, took possession of the port of Brill. This trivial success roused the spirits of the Netherlanders, and several places in Zealand and Holland declared for the Orange party. At length a convocation of nobles and deputies from the principal towns in Holland took place at Dordrecht, and forming themselves into an independent state, chose William for their chief. Convinced by the massacre of the Protestants in France, that it was in vain to expect assistance from that quarter, he dismissed his troops, and retired to Holland; and whilst Alva was exercising his usual severities, the people of Holland and Zealand alone remained in arms against the Spanish government; and the presence of William gave order and stability to the new republic. Although the duke of Alva was recalled from his government in 1573, the cause of independence was in a very precarious state. However, in 1574, the states of Holland and Zealand conferred on William the sovereign authority during the war, and formed a treaty of union and alliance with each other. Peace with the court of Spain could not be obtained otherwise than on terms which could not be accepted; and the aspect of affairs in 1576 was very discouraging. At length, however, the death of Requesens, who had succeeded Alva as governor, and the depredations to which the towns of Brabant and Flanders were exposed, favoured William in his efforts to accomplish a general union of the provinces of the Low Countries for mutual defence; and this was effected by the treaty, called the pacification of Ghent. William was now justly regarded as the true patron of public liberty. At the beginning of the year 1579, the duke of Parma being the Spanish governor, the union of Utrecht was signed, which was the basis of the confederation of the Seven United Provinces, all of which, by their deputies, concurred in forming it. When the separation of the Catholic and Protestant Netherlands took place, the latter, being distressed, sought the assistance of France, by nominating, in 1580, the duke of Anjou, brother to Charles IX. king of France, for their sovereign, and renouncing their allegiance to Philip; but the administration of Holland and Zealand was still entrusted with the prince of Orange. Philip, ascribing this measure to William, issued an edict of proscription against him; in consequence of which his life was in danger, and an attempt was made to assassinate him. At length he fell a victim to the fanaticism of a native of Franche-Compte, who was urged forward by a Cordelier and a Jesuit, who, under pretence of business, obtained access to him, and shot him through the body. He fell, and ejaculating "My God! have mercy upon me and thy poor people," instantly expired, on July 10, 1584, having nearly completed his 52d year. He was interred with great honour and testimonies of respect, at Delft. He was four times married, and had issue by each wife. His second son, Maurice, succeeded to his authority in the United Provinces. (See MAURICE.) William, having been educated in a court, acquired the manners and habits of a statesman, and was charged with dissimulation and proud ambition. But his objects were always pure and patriotic, and he zealously preserved the liberties of his country; and, though he has been traduced by the advocates of despotism, he has received the highest tokens of respect from a people who gratefully acknowledge him as the principal author of their freedom and independence. Univ. Hist. Gen. Biog.

WILLIAM of Wykeham, an English prelate, was born in 1324, at Wykeham in Hampshire, and by the liberality of a patron, educated at Winchester school, and afterwards recommended to Edyngdon, bishop of Winchester, who introduced him into the service of king Edward III. about his

23d year. Acquiring extraordinary skill in architecture, he was appointed in 1356 clerk of the king's works in two manors, and surveyor of the royal works at the castle and in the park of Windsor. The king was so highly satisfied with his conduct in these similar departments, that he recommended him by several preferments, civil and ecclesiastical. In 1359 he was nominated chief warden and surveyor of the royal castles of Windsor, Leeds, Dover, and Hadlam, and of several other castles, manors, and parks. Whilst he had only the clerical tonsure, he enjoyed many ecclesiastical dignities; and, in order to his further advancement in the church, he was ordained priest in 1362. In the following year he was made warden and justiciary of the royal forests south of Trent, and in 1364 keeper of the privy-seal. He was also chief of the privy-council, and governor of the great council; and besides other civil preferments which he enjoyed, he succeeded Edyngdon, in 1366, as bishop of Winchester, which paved the way for his elevation to the post of high-chancellor in 1367, of which latter dignity, however, he was divested in 1370. Thus possessing ample means of munificence in a state of celibacy, and a liberal spirit, his profession as an architect led him to repair and erect numerous buildings in his fee at an expence of no less than 20,000 marks. He also directed his attention to the improvement and proper discipline of the religious houses comprehended within his diocese. For the better education of his clergy, he laid the foundation of a college in Oxford, which was to be supplied with students from a seminary at Winchester. He was interrupted, however, in his liberal designs of general utility by an impeachment for misconduct in the administration of public affairs, occasioned by the influence of the duke of Lancaster, who had conceived a prejudice against him; and, in consequence of this impeachment, his temporalities were seized to the king's use, and he was banished from court. The clergy, however, interfered, and the people regarded him as a sufferer from the duke's exorbitant power; so that a tumult ensued, that procured the restoration of his temporalities, and his recovery of the royal favour, a little while before the king's death. During the turbulent reign of Richard II. Wykeham conducted himself with caution, and succeeded in the establishment of his two colleges. For that at Oxford he obtained a patent in 1379, and it was completed in 1386. It is now known by the name of the New college. His college or school at Winchester was finished in 1393. He also undertook the repair of the cathedral, which was a Saxon edifice of the eleventh century, and in the course of ten years rebuilt it in the Gothic style. (See WINCHESTER.) In 1384 he was induced, against his inclination, to accept the office of high-chancellor, which he resigned again in 1391, after having restored the public tranquillity. When the king recovered his authority, he procured a parliament in 1397, which impeached several of the commissioners, who had almost divested him of his authority, of high treason; but Wykeham, who was one of them, escaped with a forced loan of 1000*l.* He attended the first parliament of Henry IV. in 1399, which deposed Richard, but was not present at the council, which adjudged him to perpetual imprisonment. As his health declined, he was disabled from performing the duties of his office; and therefore nominated coadjutors in his bishopric, settled all his temporal and spiritual concerns, and with tranquillity waited his dismissal from the world. This happened in September 1404, when he had finished his 80th year. His remains were interred in his own chapel or oratory in Winchester cathedral, where a tomb of white marble was erected to his memory. Lowth's Life of William of Wykeham. Biog. Brit.

WILLIAM, *Sweet*, in *Botany*. See DIANTHUS, and PINK.

WILLIAMS, DANIEL, D.D. in *Biography*, an eminent non-conformist divine, was born at Wrexham, in Denbighshire, about the year 1643 or 1644. The disadvantages of his early education were counterbalanced by the natural vigour of his mind, and by future application. Devoting himself to the ministry among Protestant dissenters, he was one of the first who had resolution to engage in it, after the privations and sufferings which followed the Act of Uniformity in 1662. At the age of 19 years he was admitted a preacher among the Presbyterians, and for several years officiated occasionally in several parts of England. Being here in danger of persecution, he accepted an invitation to become chaplain to the countess of Meath in Ireland, where dissenters enjoyed a greater degree of liberty; and some time afterwards he became pastor to a respectable congregation in Wood-street, Dublin. Here he continued for nearly twenty years, exercising his ministry with acceptance and usefulness, and conducting himself so as to maintain harmony with his brethren in the ministry, and to secure respect and esteem from the Irish Protestants in general. During his residence in Dublin, he married a lady of an honourable family, with a considerable estate. Towards the close of the reign of James II., his opposition to popery rendered his situation in Ireland unpleasant to him, and he therefore came over to England in 1687, and settled in London. Here he joined those ministers who opposed an address to the king on occasion of his dispensing with the penal laws; and by his firmness and intrepidity contributed in no small degree to their unanimous rejection of it. Out of his own funds, and by his wealthy connections, he procured relief for those Irish Protestants who sought refuge in London from the tyranny and persecution of Tyrconnel. After the Revolution in 1688, which was an event that gave him and his brethren inexpressible satisfaction, he was often consulted by king William on Irish affairs; and his reports concerning the abilities and character of Irish refugees, who were capable of serving the government, were duly regarded. On occasion of his visit to Ireland, in the year 1700, for settling his own affairs, his conduct in the instances now specified was gratefully acknowledged. Towards the latter end of the year 1688, he was unanimously chosen pastor to a numerous congregation of Presbyterians in Hand-alley, Bishopsgate-street; and in this connection he spent the remainder of his days, devoting to charitable purposes the salary which he received from his congregation. With the famous Richard Baxter he cultivated an intimate acquaintance; and at his death, in 1691, he was chosen to succeed him at the Merchants' Tuesday lecture in Pinners'-hall. Some of his fellow-lecturers advanced what he conceived to be Antinomian tenets; and these dangerous notions he thought it to be his duty to oppose. Hence arose a suspicion of his orthodoxy, and an attempt to exclude him from the lecture. Their design was frustrated by a majority of the subscribers; but as their opposition was inveterate, it was thought most advisable to separate and to establish another Tuesday lecture at Salters'-hall. Three of the most respectable of the old lecturers, *viz.* Dr. Bates, Mr. Howe, and Mr. Alfop, seceded with Mr. Williams.

Upon the publication of the works of Mr. Crisp, who avowed himself the champion of Antinomianism, Mr. Williams undertook to refute them; and in 1692 published his "Gospel Truth stated and vindicated, &c." 8vo.; a work which, though now almost forgotten, was deservedly approved by the principal London ministers of that period; and as it is distinguished by great clearness and strength of

argument, as well as a truly Christian temper, it served to check the pernicious errors which were then industriously circulated. It was defended by the author in his "Defence of Gospel Truth, &c." 8vo., and in a "Postscript" to a new edition of his work, and also in other pieces. Against the charge of Socinianism, an appeal was made to Dr. Stillingfleet, then bishop of Worcester, and Dr. Jonathan Edwards of Oxford, who were deemed masters and judges in this controversy; and they honourably acquitted the author, with many expressions of respect for him. Disappointed in their efforts to induce suspicion of his orthodoxy, his enemies indulged their malignity further by arraigning the purity of his morals. Indignant as he well might be at this attack, he submitted his conduct to the investigation of the United London Ministers, who concurred in the report of their committee, "that he was entirely clear and innocent of all that was laid to his charge." The attachment of his congregation, it should be observed, was not in the least degree diminished by the malignant misrepresentations of his enemies.

In the year 1701, Mr. Williams, after having been for some time a widower, married a second wife of considerable fortune and distinguished worth, who survived him.

During the reign of queen Anne he exerted himself, though ineffectually, in opposing the bills against occasional conformity, and for imposing the sacramental test upon the dissenters in Ireland. In 1707 he used all his influence with his friends in Scotland in promoting the union between the two kingdoms; and in the year 1709 he was honoured with the degree of D.D. by the universities of Edinburgh and Glasgow. Availing himself of his long acquaintance with the earl of Oxford, he took the liberty of remonstrating against the political measures which he was pursuing. The doctor's frankness did not please the statesman; and his resentment against him for declaring unfavourable sentiments of the measures of his administration, and communicating them to his friends in Ireland, was deep and permanent. Upon the accession of king George I., he had the honour of presenting an address of congratulation to his majesty, at the head of the Protestant dissenting ministers of the different denominations residing in London and its vicinity; and it has been ever since the custom for the body of such ministers to present addresses on all public occasions, and they have the honour, as a body, of being received on the throne, and by their committees in the closet, and of receiving a written answer. Soon after the accession of George I., the health of Dr. Williams began to decline; and at length an asthmatic disorder terminated his life on January 26, 1715-16, in the 73d year of his age. In the sequel of this article we shall take advantage of literally transcribing the well-written account given of Dr. Williams by the Rev. Mr. Morgan, the highly respectable and much esteemed librarian of the excellent institution which he has established; under whose inspection and care this library is gradually rising into a reputation, which, by the contributions of its friends in books and money, and by the annual appropriation of a small sum out of the surplus of its founder's bequests, will vie with the principal establishments of a similar nature in the city of London.

"He had been blessed by nature," says our biographer, "with a strong and vigorous constitution, and possessed a sound penetrating judgment, and great strength of memory. The subjects of his pulpit performances were always practical and useful; his sentiments solid, pertinent, and distinguished by an uncommon variety; and his manner of enforcing them powerful and impressive. He was remarkable for his boldness and courage in avowing and defending what

he conceived to be truth of importance, and 'pursued what he thought right with a blunt integrity and unshaken resolution.' At the same time his candour towards those who differed from him, his kind treatment of persons who had endeavoured to injure his own reputation, and his conscientious tender regard for that of others, were prominent features in his character. He was a steady non-conformist upon principle; yet he maintained a charitable disposition towards the established church, and at the Revolution was very desirous of promoting the scheme of a *comprehension*. Though he possessed an ample fortune, he exercised great frugality in his personal expences, for the noble purpose of being more useful to others who stood in need of assistance, and of more effectually serving the great interests of truth and virtue. The same laudable views governed him in the final disposal of his property. By his last will, besides liberal benefactions to numerous benevolent and charitable institutions in London and Dublin, he provided for the support of an itinerant preacher to the native Irish, of two persons to preach to the Indians in North America, and of several charity-schools in England and Wales. He directed that a certain fixed sum, from the income of his estates, should be appropriated to the assistance of poor ministers, the widows of poor ministers, students for the ministry, and to other benevolent purposes. He also left estates to the university of Glasgow, which at present furnish handsome exhibitions to six students for the ministry among Protestant dissenters in South Britain, who are to be nominated by his trustees. The last grand bequest in his will was for the establishment of a library in London, for the benefit of the public. Having formed this design, he purchased Dr. Bates's curious collection of books, which he added to his own, and directed his trustees to provide a proper building for their reception. Such an edifice was erected by them in Red-Cross-street, Cripplegate, where the library was opened in 1729, and admission to it is easily obtained by persons of every description, without any exception, upon application to one of the trustees. Since it was first established, very considerable additions have been made to it by legacies, as well as gifts of money and books; and it now contains upwards of 16,000 volumes, many of which are very valuable and rare, in the various departments of literature and science. The founder's works were collected together, and printed at different periods, in 6 vols. 8vo.; the last consisting of Latin versions of several of his tracts, which he directed to be published in that language for the use of foreigners." Memoir prefixed to his Works.

WILLIAMS, in *Geography*, a township of Pennsylvania, in Northampton county, with 1243 inhabitants; 60 miles N. of Easton.

WILLIAM'S Port, a town of Maryland, on the Potomack; 5 miles S.W. of Hagars Town.

WILLIAM'S River, a river of Vermont, which runs into the Connecticut, N. lat. 43° 10'. W. long. 72° 24'.

WILLIAMSBOROUGH, a post-town of North Carolina, on a creek which falls into the Roanoke; 48 miles N.E. of Hillsborough.

WILLIAMSBURG, a county of the state of South Carolina.—Also, a county of the state of Virginia.—Also, a town of Virginia, situated on an isthmus between York river and James river, a creek from each river coming up within a mile of the town, but not navigable for large vessels. It was at one time the seat of government and residence of the governor, now removed to Richmond. It contains about 200 houses, and 1200 inhabitants. The principal buildings are a college and town-house, an episcopal church, and an hospital for lunatics; 50 miles E.S.E. of Richmond. N. lat. 37° 13'. W. long. 76° 50'.—Also,

a town of Massachusetts, in Hampshire, with 1122 inhabitants; 8 miles N.W. of Northampton.—Also, a town of New York, on the Genesee; 288 miles N.N.W. of Philadelphia.—Also, a town of the state of Ohio, on the Little Miami, in the county of Clermont, with 1251 inhabitants.—Also, a town of Maryland; 4 miles N. of Talbot.

WILLIAMSEURG, or *Jonestown*, a post-town of Pennsylvania; 23 miles E.N.E. of Harrisburg.

WILLIAMSON, a township of Ontario county, in New York, 206 miles from Albany, bounded N. and W. by lake Ontario. In 1810 the whole population consisted of 1139 persons, and it had 55 senatorial electors. A red oxyd of iron is found in this town, which is a good pigment for painting.

WILLIAMSON, a county of West Tennessee, with 13,153 inhabitants, including 3985 slaves.

WILLIAMSPORT, a post-town of Pennsylvania, on the west branch of the Susquehanna, in the county of Lycoming, with 344 inhabitants.

WILLIAMSTOWN, a township of the state of Vermont, in Orange county, with 1353 inhabitants; 60 miles N. of Norwich.—Also, a post-town of North Carolina, on the Roanoke; 55 miles W. of Halifax.—Also, a town of Massachusetts, in the N.W. corner of the state, in the county of Berkshire, with 1843 inhabitants; 132 miles W.N.W. of Boston.—Also, a post-township of Oneida county, in New York, erected in 1805, from a part of Mexico, and consisting of two townships of Scriba's patent, each being six miles square. The population in 1810 consisted of 562 persons, and 82 senatorial electors. The post-office was established in 1812.

WILLICHIA, in *Botany*, was so called by Mutis, after Dr. Christian Lewis Willich, a physician at Clausthal, in Lower Saxony, who published at Gottingen, in 1747, 1762, and 1766, various observations and illustrations of Botany, of more or less importance, chiefly relating to the determination of species and their synonyms, with cursory remarks on variations or irregularities of structure, exceptions to received characters, &c. The author died in 1776.—Linn. Mant. 553. Schreb. Gen. 32. Willd. Sp. Pl. v. 1. 189. Vahl Enum. v. 2. 39. Mart. Mill. Dict. v. 4. Juss. 418. Poir. in Lamarck Dict. v. 8. 798.—Class and order, *Triandria Monogynia*. Nat. Ord. uncertain, Juss. We should presume *Scrophularia*.

Gen. Ch. Cal. Perianth inferior, of one leaf, in four ovate, acute, spreading, permanent segments. Cor. of one petal, wheel-shaped, twice the length of the calyx: tube scarcely any: limb flat, in four roundish, convex segments. Stam. Filaments three, inserted into the clefts of the limb, except the lowermost, and shorter than its segments; anthers erect, roundish, of two cells. Pist. Germen superior, roundish, compressed; style thread-shaped, the length of the stamens, declining towards the lower cleft of the corolla; stigma obtuse. Peric. Capsule roundish, compressed, sharp-edged, of two cells and two valves, with an opposite partition. Seeds several, roundish, minute. Receptacle glo-bular, formed of two hemispheres.

Ess. Ch. Calyx four-cleft. Corolla four-cleft. Stamens in three of its clefts. Capsule superior, of two cells, with many seeds.

1. *W. repens*. Creeping Willichia. Linn. Mant. 558. Willd. n. 1. Vahl n. 1.—Gathered in Mexico, by Mutis, whose description, communicated to Linnæus, is our only source of information concerning this plant. The root is fibrous, annual. Stem herbaceous, creeping, thread-shaped, branched, hairy, about two feet in length. Leaves alternate, stalked, rather distant, orbicular, somewhat peltate,

crenate, hairy, an inch in diameter; reddish underneath. *Footstalks* very long, hairy, thicker than the stem. *Flower-stalks* axillary, in pairs, single-flowered, thread-shaped, hairy, the length of the footstalks. *Flowers* small, rose-coloured, with a hairy calyx.

There is no specimen in the Linnæan herbarium.

WILLIESBURG, in *Geography*, a post-town of Virginia; 2½ miles S.S.W. of Washington.

WILLIMANTIC, a river of Connecticut, which runs into the Shetucket at Windham.

WILLINCK, a large township of New York, at the S. end of Niagara county, erected in 1808; 315 miles W. of Albany. It comprises about eighteen townships of the Holland company lands. The general character of the soil is, that it is good land for farming. In 1810 the population consisted of 2028 persons, and there were 260 senatorial electors.

WILLING'S CREEK, a river of West Florida, which runs into the Mississippi, N. lat. 30° 49'. W. long. 91° 21'.

WILLINGBOROUGH, a town of New Jersey, in Burlington county, with 619 inhabitants; 14 miles N.E. of Philadelphia.

WILLINGTON, a town of Connecticut, in Tolland county, with 1161 inhabitants; 6 miles E. of Tolland.

WILLIS, BROWNE, in *Biography*, an eminent antiquary, the grandson of Dr. Willis, a celebrated physician, was born at Blandford in 1682, and was removed from Westminster-school in the year 1690 to Oxford, where he was admitted a gentleman-commoner of Christ-church; and after leaving the university he prosecuted his studies for three years under Dr. Wotton. When he came into possession of the family estate, he was returned in 1705 as a representative for the town of Buckingham. In 1715 and 1716 he published two parts of a work, intitled "Notitia Parliamentaria; or, a History of the Counties, Cities, and Boroughs in England and Wales, with Lists of all the Knights, Citizens, and Burgeſſes," 8vo., to which in 1750 he added a third part, being an appendage to the journals of the house of commons, then printed. On the revival of the Society of Antiquaries in 1717, he was chosen a member; and he sustained his reputation as an antiquary by various writings, among which are, "Surveys of the Four Welsh Cathedrals;" "History of the United Parliamentary Abbeys and Conventual Cathedral Churches;" "Survey of the Cathedrals of England, with Parochiale Anglicanum," 3 vols. 4to.; "History and Antiquities of Buckingham." In 1723 he received, in consideration of his literary merit, from the university of Oxford, the degree of A.M. by diploma. He manifested his attachment to the church by expending considerable sums in repairing those in the country, and thus injured his own fortune. But frugality in his personal and domestic expences compensated this injury. He possessed a fine cabinet of English coins, which in 1741 he presented to the university of Oxford; the university, in consideration of his family, liberally paying for those of gold by weight, and conferring upon him the degree of LL.D. With many peculiarities in his character, he claimed respect as a man of moral worth from those who knew him. To him belonged the honour of having first placed the English ecclesiastical history and antiquities upon the firm basis of records and registers, which he assiduously searched. He died in 1760, in the 78th year of his age. Biog. Brit.

WILLIS, THOMAS, an eminent physician, was born in 1621-2, at Great Bedwin, in Wiltshire; and in 1636 admitted into Christ-church college, Oxford, where he took the usual degree with a view to the clerical profession. But he changed his purpose, and studied physic, taking his

bachelor's degree in 1646, and commencing medical practice at Oxford. He distinguished himself by his steady attachment to the church of England, and also by his love of science, so that he became one of the first members of that philosophical society at Oxford, which laid the foundation of the Royal Society of London. As a chemist, which was the character under which he was ambitious of excelling, he published in 1659 a work, intitled "Diatribe duæ; prior agit de Fermentatione, altera de Febribus. His accessit Dissertatio epistolica de Urinis." The recompence of his attachment to the cause of episcopacy and loyalty was the Sedleian professorship of natural philosophy at Oxford, conferred upon him after the Restoration, by the recommendation of archbishop Sheldon, soon after which he received the degree of doctor. Upon the establishment of the Royal Society, he was one of its first members. In the year 1664, when he is said to have discovered, and brought into use, the mineral water of Aftrop in Northamptonshire, he published his "Cerebri Anatome; cui accessit Nervorum Descriptio et Usus." This work, on which his reputation principally depends, was followed in 1667 by his "Pathologia Cerebri et Nervosi Generis, in qua agitur de Morbis convulsivis, et de Scorbuto." Before this year he was settled in London, and being nominated a physician in ordinary to the king, was advancing to the first rank in practice. His next publication was intitled "Adfectionum quæ dicuntur Hystericæ et Hypochondriacæ Pathologia Spasmodica, vindicata contra responsionem epistolarem Nath. Highmori. Cui accesserunt Exercitationes Medico-Physicæ de Sanguinis Accensione, et Motu musculari," 1670. On occasion of the loss of his wife, a daughter of dean Fell, he amused himself by writing his work "De Anima Brutorum quæ Homini Vitalis ac Sensitiva est; Exercitationes duæ," 1672, in which he considers the soul of brutes as the same with the vital principle in man, corporeal in its nature and perishing with the body. After his second marriage, he began to print in 1673 his "Pharmaceutice Rationalis, sive Diatriba de Medicamentorum Operationibus in Humano Corpore;" but he did not live to publish this work, as he was carried off by a pleurisy in 1675, at the premature age of 54, in the full vigour of his faculties and zenith of his reputation. Dr. Willis had no powers for appearing with advantage and brilliancy in society; but he was intent on science and practice, frugal, pious, and charitable. His works engaged great attention on their first publication; but in consequence of modern improvements, they have sunk in the public estimation, though they are not altogether neglected. They are written in a rich and elegant Latin style. Haller. Biog. Brit.

WILLIS, in *Geography*, a town of the state of New Jersey; 33 miles S.E. of Burlington.

WILLIS'S CREEK, a river of Virginia, which runs into James river, N. lat. 37° 40'. W. long. 78° 18'.

WILLIS'S ISLAND, a small island in the South Atlantic ocean, near the north-west coast of the island of Georgia, so named by captain Cook, from one of his crew who discovered it in the year 1775. S. lat. 54°. W. long. 38° 23'.

WILLISAU, a town of Switzerland, and capital of a bailiwick, in the canton of Lucerne; 15 miles W. of Lucerne.

WILLISTON, a post-town of the state of Vermont, in the county of Chittenden, with 1195 inhabitants; 25 miles N. of Newhaven.

WILLISTOWN, a township of Pennsylvania; 15 miles S.W. of Philadelphia.

WILLMAR, a town of the county of Henneberg; 7 miles S.E. of Meinungen.

WILLOBOCKE, a river of Yorkshire, which runs into the Swale.

WILLONGTALYS, a lake of Vermont. N. lat. $44^{\circ} 45'$. W. long. $71^{\circ} 58'$.

WILLOUGHBY, a town of England, in the county of Warwick, situated on a navigable canal, on the borders of Northamptonshire; 14 miles S.E. of Coventry.

WILLOUGHBY Bay, a bay on the south-east coast of the island of Antigua. N. lat. $17^{\circ} 10'$. W. long. $61^{\circ} 25'$.

WILLOUGHBY Lake, a lake of the state of Vermont.

WILLOW, &c., in *Botany*. See SALIX.

Our common willows in the spring season, when they are in flower, produce a quantity of cottony matter, which might be put to some use.

The Chinese are industrious enough to collect this cotton as it falls from their willows; and the women and children, among the poorer people, card it, and pick out the seeds, and render it fit for many uses in the place of cotton.

The poor people, in some part of the Indies, make a fort of liquor of the flowers of their willows before they are opened, which intoxicates them very suddenly; and the dry husks of the same tree remaining after the flowers and seeds are fallen, are wholesome as food, people in time of famine having lived upon them, boiled in water.

The wood of the willow, though in itself very light and spongy, is yet of a nature to bear the injuries of wet better than almost any other kind. It is used by the Chinese on this occasion, in the making of their wells, and on all other occasions where wood is to stand under water, and succeeds perfectly well. *Observ. sur les Coutumes de l'Asie*. For the uses to which willow-bark and wood are applied, see SALIX, and GUNPOWDER.

WILLOW, in *Agriculture*, a well-known tree, of which there are several different species or kinds; but those mostly cultivated for farm purposes are, the common white willow, the purple or red willow, the fallow, and the broad-leaved or Huntingdon willow.

The first is a tall-growing tree, of the deciduous kind. It has a fine silvery appearance in the leaves; is quick of growth, and the wood is very useful where lightness and cleanness of the grain is beneficial, as for hurdles, gates, hop-poles, &c.

The second is a free-shooting willow; but its wood is inferior for many uses, especially those of the farmer.

The third sort delights in a rather dry soil, being a tree below the middle growth. It has numerous branches, of a smooth appearance, and dark green colour. Its wood is very useful for hurdles and other similar purposes of the farmer.

It has two varieties, the long-leaved, and the striped fallow, both which are very useful.

The fourth sort, or red-hearted willow, is supposed by some as the best sort for planting, for the use of the farmer, as growing quickly; but the great use to which they are applied is that of making hurdles, stakes, gates, and farming implements, being a wood uncommonly tough and light, owing, as is conceived, to a new method used in planting them close to the ground. If it is the design of the planter to let them grow into timber, (which would be far superior to deal for the purpose of flooring, or other light work, particularly as it will neither splinter nor fire; and if suffered to remain for twenty or twenty-five years, would make good masts for small craft, as they shoot up perfectly straight, and without any collateral branches,) it is necessary, at the first or second year's growth, to observe which pole is the strongest, as the remaining poles must be cut away. In about fifteen years' time it is supposed they will want

thinning; of course the inferior must be taken out and the superior be suffered to remain.

In cultivating them on waste moist lands, laying out the ground into lands, like hop-lands, as from three to four yards wide, with a ditch on each side; three feet wide at the top, one foot at the bottom, and two and a half deep, is advised by a late writer as the best mode from much experience. The earth that comes out of the ditch should be thrown on the land. But if there is not fully sufficient fall for the water to get off, the ditch should be deeper and wider, till there is near a yard of earth above the level of the water. As soon as this is done, the ground must be double dug, that is, trenched two spades' depth, except it be very boggy, which will afford room for the plants to shoot, and will save the expence of weeding, which otherwise must be incurred in the first summer after the plants are set; for if they are not kept clear of weeds the first year, the hopes of the planter will certainly be destroyed.

In respect to the times of planting, they must be from January to the end of March; but the sets for that purpose should be cut from December to the end of February, when the sap is down. And the reason is, that if poles are cut in the spring (the sap being up), the stool will at least be weakened by bleeding, if not killed; and of course prevented from shooting so vigorously as if cut at the preceding time.

In regard to the sets or truncheons, they may be cut from twenty inches to two feet long; particular care should be taken in the cutting, that the bark be not fridged or bruised, or in any other respect injured; for in that case the plant will be weak and puny.

The poles have been sold at eight years' growth for 21*l.* per acre, net-money; the kids or brushwood pay for the felling. Had they been suffered to have stood two years longer, they would, it is said, have produced 30*l.* per acre.

The plantation of the basket and cooper's willow is an object of importance in those waste and neglected corners which are to be found upon every estate and farm.

The refuse dwarf willows or osal, as it is termed, are used in the fisheries and basket-work, and will pay, *communibus annis*, for the labour. The cooper's-willow differs from the common or basket-willow; the former is known by a single bud or eye throughout the rod, which simply throws out a leaf; the latter by a double or flattened eye, which produces a branch or sprig. The former is applicable to every purpose; the latter the cooper rejects: of course the former should be propagated.

Plantations of the willow kind have been vastly increased, indeed, in many parts of the country within these few years.

WILLOW-Galls, in *Natural History*, the name given by authors to certain protuberances found very frequently on the leaves of the several species of willow, which are properly galls, each containing the worm of a fly, and owing its existence to that insect.

The galls are usually of a roundish or oblong figure, and are equally protuberant on each side of the leaf: they are of a pale green at first; but they afterwards become yellowish, and finally reddish. The surface of these is seldom perfectly even, but usually has several little prominences and cavities in it. When this gall is opened, there is found in it a worm resembling a caterpillar in figure, having a smooth annulated body, a hard brown head, and twenty legs; and by Reaumur called false or bastard caterpillar. This creature, when the gall is young, is blue; it afterwards becomes greenish; and finally, when the gall becomes red, it is white. This insect seems to eat in its prison more voraciously than any

any other gall-insect whatever; for while the gall grows in size, it becomes also thinner in every part; so that the creature, at the proper time, has but little difficulty to get out. *Reaum. Hist. Insect. vol. vi. p. 211.*

When the time of the last change of this insect draws nigh, it leaves the tree, and descending to the earth makes its way into it in a proper place, and then becomes a nymph, out of which at a proper time issues a four-winged fly.

The flies which are produced in April copulate almost as soon as freed from their exuvia of the chrysalis state, and the females soon after lodge their eggs in the leaves of the willows. This is all done before the end of April, and the young ones hatched of these eggs live but a short time before they pass into the chrysalis state, and living flies are hatched from these in June. The young ones of this brood pass their chrysalis state in the earth, and appear not during the whole winter, till the spring sun enlivens them again. There is, beside these, another kind of galls of the willow-leaves, which are of the class of those, each of which contains several cells; in each cell of these there is found a small white maggot, the offspring of the egg of a two-winged fly, which, after passing the chrysalis state in the earth, also comes out in the form of its winged parent. The cells in the galls are different in number in the several galls, and are from four or five to twenty: they have no communication with one another, but each worm lives in its own cell.

Beside these there is also sometimes found in these galls a worm of a brownish-white colour, having two hooks in its head, and no legs at all. This has all the appearance of a carnivorous animal, and probably was deposited there in the egg-state by its parent, not to feed on the gall, but on its defenceless inhabitant. This worm finally becomes a small blueish beetle, and is often found alone in the cavity of the gall, often in company with its proper inhabitant, sucking its juices as it feeds on those of the plant. There seem to be several species of these devourers common to these galls; since Vallisnieri observed, in the boxes where he kept these galls to produce the animals from thence, many species of small beetles, and several distinct kinds of flies, which were probably the last state of several kinds of carnivorous worms, which had preyed upon the proper inhabitant of the galls. *Vallisnieri, Dialog. des Insect.*

WILLOW-Herb, or *French WILLOW*, in *Botany*. See *EPILOBIUM*.

WILLOW-Herb is a name sometimes given to the *lythrum* or purple loose-strife. See *LYTHRUM*.

WILLOW, Sweet, Dutch WILLOW, GALE, or Candle-Berry MYRTLE, in *Botany*. See *CANDLE-Berry-Tree*, and *Candle-Berry MYRTLE*.

WILLOW-Weed, in *Agriculture*, a term provincially applied to smart-weed, or *perficaria*, which is a troublesome weed on many places in the corn-fields and other tillage-lands. See *WEED*.

WILLS, in *Geography*, a town of Ohio, in the county of Guernsey, with 659 inhabitants.

WILLSBOROUGH, a post-township of Essex county, in New York, with a post-office, 530 miles from Washington, erected in 1788, then in Clinton county, and very extensive; from which several towns have been since erected. It is bounded N. by Chesterfield, E. by Lake Champlain, in the state of Vermont, S. by Essex, and W. by Lewis. Along the lake the land is level and tolerably productive. A small well-drain affords many scites for water-works; and iron-ore of the best quality is found in great abundance. The population consists of 668 persons, and the senatorial electors are 57. Here are, one distillery, a forge for making

bar-iron, an anchor-shop, a carding-machine, and a clothiery, besides a considerable number of grain and saw mills.

WILLSBOROUGH, a township of New York, near Crown Point.

WILLSTADT, a town of Sweden, in the province of Smaland; 50 miles W. of Wexio.—Also, a town of Germany, in the county of Hanau Lichtenberg; 7 miles S.E. of Straßburg.

WILLUGHBEIA, in *Botany*, was so named by Schreber, in memory of our great English naturalist, Francis Willughby, esq. of Middleton-hall, Warwickshire, the friend of RAY, in our biographical account of whom the reader will find many particulars relating to Mr. Willughby and his family. This gentleman may well claim botanical distinction, on account of his enquiries into the philosophy of vegetation, in conjunction with his illustrious associate, during the spring of 1669.—*Schreb. Gen. 162. Willd. Sp. Pl. v. 1. 1231. Mart. Mill. Dict. v. 4. (Amelania; Aubl. Guian. 265. Juss. 148. Lamarck Dict. v. 1. 125. Illustr. t. 169. Pacouria; Aubl. Guian. 268. Juss. 148. Lamarck Dict. v. 4. 691. Illustr. t. 169.)—Class and order, Pentandria Monogynia. Nat. Ord. Contortæ, Linn. Apocinea, Juss.*

Gen. Ch. Cal. Perianth inferior, of one leaf, fleshy, in five deep acute segments, very small. *Cor.* of one petal, valver-shaped: tube cylindrical, enlarged at the bottom: limb horizontal, in five deep, oblique, acute, wavy segments, more dilated at one side than the other, lying over each other at the base. *Stam.* Filaments five, very short, inserted into the tube just above the base; anthers arrow-shaped. *Pist.* Germen superior, roundish; style quadrangular; stigma capitate, ovate, thick, friated, double-pointed, subtended by a flat orbicular disk. *Peric.* Berry ovate, coated, of one or two cells. *Seeds* numerous, angular, compressed, imbedded in pulp.

Ess. Ch. Corolla valver-shaped, contorted. Stigma capitate. Berry coated, with many angular seeds.

1. *W. acida.* Acid Willughbeia. Willd. n. 1. (*Amelania acida*; Aubl. Guian. 266. t. 104.)—Stem erect. Flower-stalks the length of the footstalks.—Native of extensive forests in Guiana and Cayenne, bearing flowers and fruit in September. The trunk of this tree is seven or eight feet high, and seven or eight inches in diameter, with a greyish bark, and soft white wood. The head consists of very numerous, straight, knotty branches, subdivided in an opposite manner. Leaves opposite, on short stalks, elliptical, somewhat pointed, entire, wavy, smooth and shining, with one rib, and many transverse parallel veins; their greatest length seven inches, by three in breadth. Flowers axillary, three or four together on one common stalk, which is hardly so long as the adjoining footstalk. Bractæe scaly, solitary at the base of each general as well as partial stalk. Corolla whitish, scarcely so large as that of *Vinca minor*. Fruit lemon-coloured, oval, corrugated or warty, two inches long, separated by a longitudinal fleshy partition, into two cells, filled with acid viscid pulp, and containing many brown rough seeds. This fruit, though milky, is wholesome. After the rind is taken off, the remainder is soaked for a while in water. The flavour is agreeably acid, notwithstanding a great degree of viscidness, by which the pulp adheres to the lips and teeth. This fruit, with or without its rind, is preserved in sugar. In the latter state it is cooling, slightly acid; in the former moderately purgative, and esteemed useful in dysenteries. The whole plant when wounded discharges a milky, very tenacious, juice.

2. *W. scandens.* Climbing Willughbeia. Willd. n. 2. (*Pacouria guianensis*; Aubl. Guian. 269. t. 105.)—Stem twining. Flower-stalks branched, as long as the leaves.—Native

Native of woods about the mouth of the creek of the Galibis in Guiana, bearing flowers, as well as fruit, in May. The *trunk* is about three inches in diameter, sending off long, knotty, trailing *branches*, which twine round the neighbouring trees to their very fummits, from whence the extremities hang down, clothed with opposite, oval, smooth, entire *leaves*, not unlike the foregoing, and about as large, on short stalks; their rib, as well as lateral veins, are prominent and reddish. The *flower-stalks* are axillary, solitary, wavy, alternately branched, resembling tendrils, terminating in several little tufts, or umbels, of yellow *flowers*, rather smaller than the first species. *Fruit* roundish or obovate, the size and colour of a quince, of an agreeable scent when ripe, pulpy, yielding but a small quantity of milky juice if cut, though all the other parts of the plant contain a great quantity of the same kind of glutinous milk as the preceding. Aublet does not mention any use to which this species, or its *fruit*, is applied.

WILLUGHBY, FRANCIS, in *Biography*, was born in 1635 of a good family in Lincolnshire, and educated in Trinity college, Cambridge, under the tuition and in habits of friendly intercourse with the excellent philosopher and natural historian, John Ray. They were intimate associates, and made a foreign tour together in the years 1663 and 1664. To birds and fishes Willughby paid particular attention, and he formed a rich museum of animal and fossil productions. In 1668 he married the daughter of sir Henry Bernard, and his family residence at Middleton, in Warwickshire, was the place of Ray's frequent resort, where he and his host prosecuted their philosophical experiments and observations, the result of which they communicated to the Royal Society, of which they were both members. This instructive and pleasant intercourse was, however, prematurely interrupted by the death of Willughby in 1672, at the age of 37. His confidence in Mr. Ray was manifested by appointing him one of his executors, and committing to him the charge of educating his two infant sons, bequeathing to him an annuity for life as a compensation. Ray ascribes to him, without any trace of adulation, singular moral excellence and high mental endowments. His posthumous work, published under the inspection of Mr. Ray, was entitled "Francisci Willughbei Arm. Ornithologiae Libri tres; in quibus Aves omnes haecenus cognitae, in methodum naturis suis convenientem reductae, accuratè describuntur. Descriptiones iconibus elegantissimis et vivarum avium simillimis aeri incisus illustrantur. Totum Opus recognovit, digestit, supplevit Johannes Raus;" Lond. fol. This work was also translated into English by Ray, and published in 1671 with large additions. Mr. Ray also collected and arranged Willughby's papers on Ichthyology. He added the two first books, and with the assistance of the Royal Society published them in 1686 under the following title: "Fran. Willughbei Arm. de Historia Piscium, Libr. quatuor, jussu et sumptu Soc. Regiae Lond. editi. Totum Opus recognovit, coaptavit, supplevit librum etiam primum et secundum integros adjecit J. Raius." Oxon. fol. The papers of Willughby in the Phil. Transf. relate to vegetation, plants, and insects. The collection of Ray contains some of his letters. Biog. Brit. Pulteney's Sketches of Botany:

WILLY, in *Geography*, a river of England, which runs into the Avon, near Salisbury.

WILLYKA, a town of Lithuania, in the palatinate of Wilna; 60 miles E. of Wilna.

WILMANSTRAND. See VILMANSTRAND.

WILMANTON, a town of New York; 50 miles N. of New York.

WILMINGTON, a sea-port town of the state of Delaware, on Brandy-wine Creek; 22 miles S.W. of Philadelphia. N. lat. 39° 45'. W. long. 75° 34'.—Also, a sea-port town of North Carolina, with about 250 houses, on a branch of Cape Fear river. In January 1781, this town was taken by the British troops; 76 miles S.S.W. of Newbern, N. lat. 34° 11'. W. long. 78° 5'.—Also, an island near the coast of Georgia, at the mouth of the Savannah. N. lat. 32°. W. long. 81° 6'.—Also, a post-town of Vermont, on Deerfield river, in Windham county, with 1193 inhabitants; 10 miles E.S.E. of Bennington.—Also, a town of Massachusetts, in the county of Middlesex, with 716 inhabitants; 16 miles N. of Boston.—Also, a town of New York; 53 miles N. of New York.

WILMOT, JOHN, in *Biography*, earl of Rochester, was the son of Henry, earl of Rochester, an eminent loyalist in the reign of Charles I., and was born in 1647, at Ditchley, in Oxfordshire. In 1659 he was entered at Wadham college, Oxford, and afterwards travelled into France and Italy under a tutor, who is said to have reclaimed him from his early licentiousness; but upon his return to the profligate court of Charles II., in which he was a gentleman of the bed-chamber, he relapsed into his former intemperance. In 1665 he went to sea, and, as it is said, behaved with great intrepidity in the attack of a castle at Bergen, in Norway, which character for courage he also maintained when he afterwards served under sir Edward Spragge. In some of his domestic adventures, however, he forfeited this kind of reputation. Welcomed in all companies on account of his wit and vivacity, he became habitually intemperate, inasmuch that, on a subsequent review of his conduct, he acknowledged that for five successive years he was never free from the inflaming effects of wine. His various adventures, in his real, or in a disguised character, have furnished many anecdotes, that have been circulated in conversation, or in books of mere amusement, but which are not worth recording in graver publications. His wit furnished in the societies which he frequented a kind of apology for his profaneness and licentiousness; and as for his poetical compositions, they were for the most part lampoons or amatory effusions, the titles of which would stain the page of biography. "In all his works, (says Dr. Johnson, meaning probably those which *can be read*,) there is sprightliness and vigour, and every where may be found tokens of a mind which study might have carried to excellence." The justice of Walpole's sentence, in his "Catalogue of Noble Authors," will be generally allowed: "Lord Rochester's poems have much more obscenity than wit, more wit than poetry, more poetry than politeness." His course of debauchery was of no long duration; for soon after the age of 30 he sunk into a state of debility and disease, which induced him to study physic, and this study permitted him to reflect on the course of his past life, the irremediable effects of which he learnt from experience. Towards the close of his short life, he became acquainted with bishop Burnet, who convinced him of the truth both of natural and revealed religion, and his mind was then impressed to such a degree, that he is said to have become a sincere penitent. His life terminated in July, 1680, soon after he had commenced his 33d year. He left a son and two daughters. Biog. Brit. Johnson. Burnet.

WILMOT, in *Geography*, a town of Nova Scotia, near Annapolis.—Also, a town of New Hampshire, in the county of Hillsborough, with 298 inhabitants.

WILNA, a city and capital of the duchy of Lithuania, on the Wilia, founded in the year 1305. This city lies in a mountainous country, on several little eminences. It is

very large, and has two considerable suburbs, called Antokolla and Rudaiſzka. In the old ruinous royal palace is the arſenal, and the hall where the court of juſtice is held; and over-againſt it is the magnificent church belonging to the caſtle, which was built in the year 1386. The treaſury belonging to this church is very rich; and it is alſo remarkable for the elegant marble chapel of St. Caſimir, whoſe ſilver ſhrine is ſaid to weigh thirty quintals. There are upwards of forty churches in this city, and among theſe are, one Lutheran and one Calviniſt church, a Jewish ſynagogue, a Tartarian church, and a Greek church; but all the reſt are Popiſh churches. Not to mention the devaſtation which Wilna formerly ſuffered from the Ruſſians in the years 1610 and 1655, and from fire in 1737, it was deſtroyed by a dreadful conflagration in the year 1748, when 13 churches, the Jewish ſynagogue, 25 palaces, 469 ſtone edifices, conſiſting of private houſes, hoſpitals, inns, baths, convents, and mills, with 146 tradeſmen's ſhops, and diſpenſaries, beſides a great number of granaries and warehouſes, were conſumed to aſhes. In 1749 another fire happened by lightning, which conſumed 6 churches, the council-houſe, 8 palaces, and 277 other ſtone buildings. The chapel of St. Caſimir was alſo burned, and the loſs ſuſtained by the deſtruction of this edifice only amounted to a vaſt ſum. The churches have been ſince rebuilt at a very great expence, and ſome of them in a more elegant manner than before; but the city has not recovered its former grandeur. Wilna is the ſee of a biſhop, founded in 1387. The univerſity was founded in 1570. It gives name to a palatinate. In 1794 it was taken by the Ruſſians, and with its territory annexed to that empire; 168 miles E. of Königſberg. N. lat. 54° 36'. E. long. 25° 18'.

WILRE, a town of France, in the department of the Ourthe; 4 miles E. of Fauquemont.

WILS, a town of the county of Tyrol, on the borders of Bavaria; 5 miles N.N.W. of Reutten.

WILSCOW, a river of Brandenburg, which empties itſelf into a large lake, communicating with the Rega, 4 miles S. of Treptow.

WILSDEN, a townſhip of England, in the Weſt Riding of Yorkſhire, near Halifax.

WILSDRUF, or **WILSDORF**, a town of Saxony, in the margravate of Meiſſen; 9 miles W. of Dresden. N. lat. 51°. E. long. 13° 8'.

WILSELMAUR, a town of Auſtria; 3 miles W. of Brugg.

WILSNACH, a town of Brandenburg, in the Mark of Prignitz. This town was anciently famous, there being no leſs than three hoſts worſhipped at this place, which hoſts they ſay, in 1383, remained untouched in the church when it was burned down, and upon each of them was ſeen a drop of blood. To theſe hoſts numerous pilgrimages were made from the remotest countries; by which means this place roſe from a village to a ſmall town. At length the hoſts were burned in the year 1552, by the Lutheran preacher, Joachim Ellefeldt; 8 miles S. of Perleberg.

WILSON, **RICHARD**, in *Biography*, the moſt eminent landſcape-painter of the Engliſh ſchool, was the ſon of a clergyman, and was born at Pineges, in Montgomeryſhire, in 1714.

Having received from his father a good claſſical education, in the courſe of which he had evinced a decided diſpoſition for drawing, he was ſent to London at the age of 15, and placed as a diſciple with an obſcure portrait-painter, named Wright. After a lapſe of ſix years, he commenced profeſſor, and under the patronage of Dr. Hayter, biſhop of Norwich, he ſoon afterwards had the honour to paint

portraits of his preſent majeſty and his brother, the late duke of York; both at that time under the tuition of the biſhop. He continued to praſtiſe portrait-painting ſome time in London, but with no great ſucceſs, and at length went to Italy to cultivate his taſte. Even there he continued to praſtiſe it, ſtill unacquainted with the genuine bias of his genius, although occaſionally exerciſing his talents and employing his time in ſtudies of landſcape. At Venice Wilſon painted a portrait of the late Mr. Lock, of Norbury-park, one of the moſt creditable of his performances in that branch of the art; and it was there that accident opened his eyes to his own peculiar gratifications, and led him into that path, by purſuing which he has obtained a name among the wortheiſt in art.

As a matter of relaxation and amuſement, he had painted a landſcape, which being ſeen by Zuccarelli, ſo warmly excited that eminent artiſt's admiration, that he adviſed Wilſon to purſue that line of art excluſively. From this time it is believed that he abandoned portraiture, and followed the judicious advice of a rival artiſt; and ſoon after he left Venice in company with Mr. Lock, and travelling ſlowly to Rome, made numerous ſtudies on the way, which are ſtill preſerved at Norbury-park. On his arrival at Rome, the advice of Zuccarelli was confirmed by Vernet and Mengs, both then in high repute. So much were they delighted with Wilſon's landſcapes, that they each offered to exchange a picture with him; a propoſal far too flattering for reſuſal. This liberality, as commendable as it is unuſual, was followed by Vernet in the handſomeſt manner, as he hung the picture by the Engliſhman in his exhibition-room, and recommended him to the particular attention of the *cognoſcenti*.

His progreſs in landſcape-painting muſt have been very rapid; indeed it muſt have had the character of being almoſt intuitive, ſince he obtained a very great degree of reputation during his ſtay in Italy, and painted many pictures there of known celebrity. He travelled with the late earl of Dartmouth to Naples, and made a number of very fine drawings for that nobleman, now preſerved by his grandſon; and for him alſo he painted two pictures, one a very fine one, a view of Rome, which has been beautifully engraved by Middiman. He was alſo employed by the late duke of Bridgewater to paint a landſcape with the ſtory of Niobe; but his grace had the bad taſte to employ Placido Conſtanza to repaint the figures. To preſerve his reputation, Wilſon painted another of the ſame ſubject, and both are now in England. He returned from Italy in 1755, and occupied apartments over the north piazza of Covent-Garden. He had merited, and here he alſo obtained celebrity, and for a while employment. Many of his principal performances appear to have been painted about this time, moſt of which are known by the fine prints engraved from them by Woollett and others; in which the grandeur, breadth, and purity of compoſition in maſs and in line, contend for admiration with the talents conſpicuous in the engravings.

Hitherto the life of Wilſon was honoured as his talents deſerved; the remainder of it exhibited a gradual declenſion, not ſo much of power as of patronage. 'Tis true he was often too free in his pencil, and too much mannered in his ſtyle; repeating himſelf, perhaps, till it became irkſome: 'tis ſaid, alſo, that he was not of the moſt tractable humour, and was low in his purſuits and aſſociations. Whenceſoever it aroſe, he was doomed to undergo indifference and neglect, and conſequently the inconveniences of lowneſs of purſe. Sometimes he was employed to paint views of gentlemen's ſeats, but probably the occupation ſuited the artiſt as little as the reſult gratified the patron. Wilſon's view of nature was far too broad for ſuitable adaptation

adaptation to such a purpose, and consequently there are not many pictures of this class to be met with which have proceeded from his pencil. The great characteristic of his works is grandeur, resulting from breadth, purity, and simplicity, united in fullness of colour and mellowness of touch. He was perfectly original in feeling and execution, more grand in general conception than Claude, though infinitely less perfect in detail; and far from travelling through his career in art, with so even a pace as his great predecessor and only rival in the more exalted style of landscape-painting before our time. Now a third shines in the same hemisphere, and Claude and Wilson find no ill-fuited associate in the name of Turner.

At the institution of the Royal Academy, Wilson was chosen one of the founders; and after the death of Hayman he was made librarian. That station he retained till his death, which happened in May 1782, in the 68th year of his age.

WILSON, THOMAS, an English prelate, was born in 1663, at Burton-in-Wirral, Cheshire, and finished his education in Dublin college, where he took his degree of arts. In 1689 he was ordained priest, and in 1692 became domestic chaplain to the earl of Derby, and attended his son, lord Strange, who was his pupil, on a tour to the continent. Upon the death of the young gentleman, he returned to England, and in recompence of his faithful services, was nominated to the bishopric of the Isle of Man, by the earl of Derby, who then possessed the sovereignty of the island. The nomination was approved by king William, and he was consecrated in January 1697-8, having received at Lambeth the degree of LL.D. The revenue of the bishopric did not amount to more than 300*l.* a year; but by some collateral advantages the bishop was enabled to exercise hospitality and charity, to repair his ruined palace, and to found a new chapel at Castletown. He also established parochial libraries, which he furnished with religious books, among which was a small tract, the first that was ever printed in the Manks language. He improved the agriculture of the island by introducing into it corn, horses, cattle, and sheep, from England; and he studied physic with a view of administering to the relief and comfort of the islanders. He published ecclesiastical constitutions, which were so much approved, that lord chancellor King said of them, that "if the ancient discipline of the church were lost, it might be found in all its purity in the Isle of Man." Bishop Wilson, chiefly with a view to the interest of religion and morality, was anxious to maintain a due regard to episcopal authority, and this anxiety led him in two instances to exceed the bounds of prudence and propriety. When some copies of the "Independent Whig" had found their way into the island, he ordered them to be seized, apprehending that they inculcated sentiments hostile to Christianity and the established church. He also involved himself in difficulties and incurred reproach by excluding from the communion the wife of the governor, on account of an act of defamation, for which she refused to ask pardon of the injured party. This led to a serious altercation with the governor, who fined both the bishop and his two vicars-general, for suspending his chaplain for disobedience in admitting the wife to communion, and who arrested them for refusing to pay the fine. Accordingly they were kept close prisoners in the castle for nine weeks, till the bishop, by application to the council in England, obtained their release. The pious and mild-tempered bishop afterwards declined prosecuting the governor for damages. From his piety and attachment to the church, he was honoured in 1707 with the degree of D.D. from the university

of Oxford, in full convocation, and in which he was afterwards aggregated at Cambridge.

Such was the bishop's zeal for doing good, that he would not quit the sphere assigned him for this purpose, though he was offered an English bishopric; in reference to which circumstance queen Caroline, directing her attention to Wilson, among a number of other prelates who happened to be at court at the same time with him, said to them, "Here, my lords, comes a bishop whose errand is not to apply for a translation, nor would he part with his spouse because she is poor." His character was in such estimation with the French minister, that he procured an order that no French privateer should commit ravages on the Isle of Man. In this retired situation his life was prolonged to his 93d year, when he calmly expired in March, 1755, leaving one surviving son, known in the political world as rector of St. Stephen's, Walbrook, and patron of the celebrated historian Mrs. Macaulay. After his death a collection of his works was published in two vols. 4to. 1781. His notes to Crutwell's Bible, which was published under the bishop's name in three vols. 4to. 1785, are of little value. The translation of the New Testament into the Manks language, which he had undertaken, was completed by his successor, Dr. Mark Hillesey. Biog. Brit. Life prefixed to his Works. Gen. Biog.

WILSON, Dr. JOHN, a native of Feversham, in Kent, was a gentleman of Charles the First's chapel, and servant in ordinary to his majesty, in the character of chamber-musician. His instrument was the lute, upon which he is said to have excelled all the Englishmen of his time; and, according to Ant. Wood, his royal master was so pleased with his talents, and had even such a personal regard for him, that he not only listened to him with the greatest attention, but frequently condescended to lean or lay his hand on his shoulder, while he was playing.

For the excellence of his performance we must now wholly depend on tradition, as the compositions he has left behind him for the lute are but feeble testimonies of a great hand. Nor will his vocal productions, or Fantasias, either in print or manuscript, generate very exalted ideas of his genius or abilities as a composer. That he was admired by his majesty, and by the lovers of music at Oxford, where he was honoured with the degree of doctor in music, 1644, and where he long resided, proves more the low state of the art at this time, before the ears of the public were rendered discriminative, by a variety of great and rival talents, than his own perfections. Little had been heard, and but little was expected. Swift says, "we admire a little wit in a woman, as we do a few words spoke plain by a parrot:" and it might more seriously be said, that the best music, during times of ignorance and inexperience, is perhaps more admired than the most exquisite productions and performance of a more enlightened period. Nothing can prove this more clearly than the unbounded and hyperbolic praises bestowed in France on the operas of Lulli, of which, at present, the whole nation is ashamed.

Dr. Wilson, indeed, seems to have set words to music more clumsily than any composer of equal rank in the profession; but as he was respected by his contemporaries, and held an exalted rank in his art, a list shall here be inserted of his works; not so much for their intrinsic worth, as to enable curious enquirers to judge for themselves of the progress which music had made in this kingdom, when such productions were in high favour, not only with the greatest personages but principal professors of the times.

"Psalterium Carolinum, the devotions of his sacred ma-

jestly in his solitude and sufferings, rendered in verse, set to music for three voices and an organ or theorbo." Folio, 1657.

"Cheerful Aires or Ballads, first composed for one single voice, and since set for three voices." Oxon. 1660.

"Aires to a voice alone, to a theorbo or bafs viol;" these are printed in a collection entitled "Select Aires and Dialogues." Folio, 1653.

"Divine Services and Anthems," the words of which are in Clifford's Collection. Lond. 1663.

He also composed music to several of the odes of Horace, and to some select passages in Aufonius, Claudian, Petronius Arbitrator, and Statius; these were never published, but are preserved in a manuscript volume curiously bound in blue Turkey leather, with silver clasps, which the doctor presented to the university, with an injunction that no person should be permitted to peruse it till after his decease. It is still among the archives of the Bodleian library.

The compositions of Dr. Wilson will certainly not bear a severe scrutiny either as to genius or knowledge. It is, however, not easy to account for the ignorance in counterpoint which is discoverable in many lutenists of these times; for having harmony under their fingers, as much as the performers on keyed instruments, it facilitates their study, and should render them deeper contrapuntists than the generality of flute-players, whose flimsy compositions are proverbial.

On the surrender of the garrison of the city of Oxford, 1646, Dr. Wilson left the university, and was received into the family of sir William Walter, of Sarfden, in Oxfordshire; but, in 1656, he was constituted music-professor, and had lodging assigned him in Baliol college, where, being assisted by some of the royalists, he lived very comfortably, exciting in the university, according to A. Wood, such a love of music, as in a great measure accounts for that flourishing state in which it has long subsisted there, and for those numerous private music-meetings, of which this writer, in his own life, has given such an amusing relation. At the Restoration, Dr. Wilson was appointed chamber-musician to Charles II.; and, on the death of Henry Lawes, 1662, was again received into the chapel-royal, when, quitting the university, he resided constantly in London, till the time of his decease, at near 78 years of age, in 1673. Burney.

WILSON, in *Geography*, a town of South Carolina; 15 miles S.W. of Queenborough.—Also, a town of Scotland, in the county of Lanerk, founded in the latter end of the 18th century, by Messrs. Wilson of London, to accommodate the workmen employed in an iron foundry there; 5 miles E. of Lanerk.—Also, a county of West Tennessee, with 11,952 inhabitants, including 2297 slaves.

WILSONIA, in *Botany*, received that appellation from Mr. R. Brown, who commemorates by it the remarkable zeal and perseverance of Mr. John Wilson, an inhabitant of Kendal, Westmoreland, author of a "Synopsis of British Plants in Mr. Ray's Method," published at Newcastle-upon-Tyne in 1744. This work, however, is incomplete, the grasses, trees, shrubs, and all the cryptogamic tribe, except Ferns, being omitted. The author, whom Dr. Pulteney supposes to have died about the year 1750, is said to have left these classes finished in MS.; but they were never published. His performance indeed is now altogether obsolete, being chiefly translated from Ray and Tournefort; though with some alterations of the system of the former, and much additional matter, respecting the stations of rare plants; all which evinces a considerable portion of practical knowledge. Copious medical information is interspersed,

and a botanical dictionary is prefixed. But the botanist of whom we are speaking is principally worthy of memory, for that indefatigable love of science, which even the most humble situation, and the most limited circumstances, could not counteract. Whether he was employed in the manufacture of knitted stockings, formerly very extensive in his native town, or whether he made shoes, his biographers are not agreed; but he contrived to attain more knowledge, and cultivation of mind, than perhaps a great majority of the gentry around him. He must have had a competent acquaintance with Latin, and he may rank as an English writer among the most respectable, upon scientific subjects, in his time. We cannot commend his prudence, if we compassionate his difficulties, when he would have sold his only cow, the support of his wife and family, to buy a copy of Morison's work. But we may be allowed to regret that his mental application did not tend to so ample a pecuniary reward, as that of the famous sir Richard Arkwright, who repeatedly incurred the censure of many a prudent friend, for neglect of business, while he was planning a scheme of unbounded profit for himself and family. We rejoice to read that the book so much desired, was presented to Wilson by a benevolent lady, who lived near him, and who by this act has afforded a lasting testimony to the worth of his character. An honest man may always hope for indulgence and assistance, if he smoothes the path of hard duty with a little mental excursion, instead of mere unprofitable recreation or dissipation, whatever may be his situation in life. Many a cow has been sold in consequence of evil propensities; few have been sacrificed to procure food for the mind.—Brown Prodr. Nov. Holl. v. 1. 490. Clafs and order, *Pentandria Monogynia*. Nat. Ord. *Convolvuli*, Juss. *Convolvulaceæ*, Brown.

Ess. Ch. Calyx pitcher-shaped, five-sided, five-toothed. Corolla funnel-shaped, of one petal; imbricated in the bud. Germen with two seeds. Style cloven. Stigmas capitate. Capsule . . .

1. *W. humilis*. Humble Wiltonia. Br. n. 1.—Discovered by Mr. Brown, in the south part of New Holland. A little, dwarf, shrubby, prostrate, much branched, downy plant. *Leaves* small, sessile, thickish, imbricated in two ranks. *Flowers* axillary, solitary, sessile, without bractæas. Mr. Brown remarks, that the natural affinity of this genus must be uncertain while its fruit continues unknown. He met with the plant after the flowers were faded, before the seed-vesel was formed, nor is he certain whether the germen consisted of one cell, or of two. He ranges *Wiltonia* next after *Cressa*, of whose place in the natural system Linnæus had formed no opinion, but which Jussieu well refers to his *Convolvuli*, notwithstanding the solitary seed.

WILSONVILLE, in *Geography*, a town of Pennsylvania; 120 miles N. of Philadelphia.

WILSTER, a town of the duchy of Holstein, on the river of the same name; 8 miles N. of Gluckstadt.

WILSUM, a town of Germany, in the county of Bentheim; 11 miles W.N.W. of Nienhuus.

WILTER, a town of the Tyrolse, on the Inn; 3 miles above Inspruck.

WILTON, an ancient market, borough, and county-town of Wiltshire, England, derives its name from the river on which it was originally built. By old writers, it was called Wile, or Wily-Vilodunum and Ellandunum; and according to Baxter it was a chief seat of the British prince, Carvilius, and thence denominated Caer-Guilou. Henry of Huntingdon says, it afterwards became the capital of the West-Saxon dominions; but Leland and Dr. Milner contend,

tend, that Winchester was the chief town of that monarchy. It is not improbable that both places were at different periods possessed and occupied by the West-Saxon kings.

Antecedent to the Norman Conquest, Wilton was certainly a place of distinguished consequence. It contained several religious establishments; and was the principal town of the county, as appears from its having given name to the shire. Leland states, that it possessed twelve parish-churches at the period of Henry III.; a statement, if fully authenticated, would afford decided proof both of its great extent and population. The West-Saxon monarchs most probably had a palace here, and conferred on this place many marks of their royal favour. During their dynasty, Wilton was a royal borough, and appears to have been the scene of several important historical events. In 823, Egbert gave battle to and defeated the Mercian army near this town, which army was commanded by their king, Beornwulf. Several other engagements between the Saxons and Danes took place at and near Wilton. One of these occurred in 871, when the valiant Alfred commanded the Saxon army against a vast horde of the Danish marauders, who having plundered and laid waste several other places, were checked in their sanguinary career near this town, and after a desperate battle were compelled to petition for mercy and peace. Again in 1003, Wilton was visited by the Danes, when part of the town was consumed. During the civil warfare between king Stephen and the empress Maud, this place was the scene of much slaughter.

Wilton continued for many centuries after the Conquest celebrated for its monastic institutions, and particularly for its abbey. This was instituted in 773 by Wulfstan, earl of Wiltshire, who, having defeated Ethelmund, king of the Mercians, repaired "a certain old church of St. Mary, at Wilton, which had been destroyed by the Danes, and placed in it a college of secular priests." After the Conquest, king William and several of his successors added greatly to the opulence of this abbey, which was dissolved in the thirty-fifth year of Henry VIII. The other monastic institutions in this town were, a house of black friars, an hospital dedicated to St. Mary Magdalen, a collegiate church, and an hospital dedicated to St. John.

Wilton, though much decayed, still retains many of its ancient privileges. It is a borough both by prescription and by charter, and is governed by a corporation of its own, consisting of a mayor, recorder, five aldermen, three capital burgesses, and eleven common-councilmen, with a town-clerk, and other officers, as fixed by the last charter granted in the reign of Henry VIII. The town sends two members to parliament, and has regularly done so since the twenty-third year of Edward I. In 1710, it was agreed that the elective franchise was vested "in the mayor and burgesses, who are to do all corporate acts and receive the sacrament." The number of voters is stated at twenty-four in the History of Boroughs, where it is also observed, that "the election of any person to be a burgess of Wilton, who has not taken the sacrament of the Lord's supper, according to the rites of the church of England, within one year before such election, is a void election." The mayor is the returning officer; and the patron of the borough is the earl of Pembroke, whose seat is in the vicinity of the town.

The county courts of justice are sometimes held here; as are likewise the elections for the county members. The precise spot where the electors meet to choose their representatives, is marked by a large stone in the Warren, at a short distance south of the town. The market-days here

were formerly Wednesday and Friday in every week; but a small one on the former day is now only continued. The fairs are held on the 4th of May and the 12th of September.

The principal public buildings in this town are the parish-church and the town-hall. The other buildings here appropriated to public purposes are two chapels, one belonging to the Methodists, and another to the Independents, a free-school, and eight alms-houses. Wilton, including the borough and parish, contains, according to the parliamentary returns of 1811, 393 houses, and a population of 1963 persons. It was formerly celebrated for its carpet manufactories, which gave employment to a large proportion of its inhabitants. The first carpet made in England was manufactured at Wilton. Fancy woollens and flannels are now the only articles of manufacture. At the eastern end of the town is,

Wilton-house, seated in a fine park. This edifice is a large, extensive pile, erected at different periods, and displays different styles of architecture. It was formerly an abbey, but the alteration of Mr. James Wyatt has destroyed every monastic part of the building. This architect (now no more) was employed by the present noble proprietor, to enlarge the mansion and adapt it for the better display of its rich stores of ancient sculpture and paintings. A principal feature in this alteration is the formation of a glazed cloister, round a central court, which contains nearly the whole collection of statues, busts, basso-relievos, &c. Another considerable novelty is a large court-yard on the north, surrounded by offices, a lodge, and a new side to the house. The approach is through a triumphal arch, which is surmounted by a bold equestrian statue of Marcus Aurelius. A vestibule leads to the cloister, both of which are filled with ancient marbles.

The collection of works of art at Wilton-house has long been highly celebrated, and different publications have been given to the world, with catalogues and accounts of the various subjects. These are, the "Ædes Pembrochianæ," by Mr. Richardson, 12mo. 1774; an eleventh edition of which was published in 1788. Gambarini of Lucca published a "Description of the Earl of Pembroke's Pictures," in 1731. Kennedy also produced a "New Description of the Pictures, &c." in 1764. Another volume in 4to., with several engravings of the sculpture, was published in 1786. Wilton-house was formerly exhibited to strangers, but the present nobleman has shut it up. Several persons of the Pembroke family have been particularly distinguished in the annals of the country; particularly in Clarendon's history. Philip Massinger, an eminent dramatic poet, was probably born at Wilton-house, as his father lived in the service of the earl of Pembroke. See Giffard's Life and Works of Massinger.

About a mile east of Wilton is Bemerton, the living of which is possessed by the Rev. William Cox, author of several valuable works of History, Travels, and Topography. It is rather singular that the rectory of Bemerton has been enjoyed by several eminent literary characters, among whom we find the names of Walter Curle, bishop of Winchester, &c. George Herbert, (commonly called the divine Herbert,) and John Norris.—*Beauties of England, Wiltshire*, 8vo. 1814; by John Britton, F.S.A.

WILTON, a town of the district of Maine, in the county of Kennebeck, containing 770 inhabitants; 60 miles N.N.E. of Portland.—Also, a town of New Hampshire, in Hillsborough county, with 1017 inhabitants; 30 miles E. of Chesterfield.—Also, a town of Connecticut, in the county

of Fairfield, with 1728 inhabitants.—Alfo, a town of South Carolina; 27 miles S.W. of Charlestown.

WILTOWN, a town of South Carolina; 21 miles W.S.W. of Dorcheſter.

WILTPERG, a town of Auſtria; 8 miles S.W. of Freyſtadt.

WILTSHIRE, an inland county, ſituated towards the ſouth-ſiſtern diſiſion of England, derives its name from the town of Wilton, which, according to ſome ancient hiſtorians, was the metropolis of the Anglo-Saxon kingdom of Weſſex. On the north and north-weiſt it is bounded by Glouceſterſhire, on the ſouth-weiſt by Dorſetſhire, on the ſouth and eaſt by Hampſhire, and on the north-eaſt by the county of Berks. Theſe boundaries are in general artificial, and form a figure approaching that of an ellipſe. Concerning the extent and ſuperficial area of this county, various are the ſtatements of different writers. In the Magna Britannia it is ſaid to be thirty-nine miles in length from north to ſouth, and thirty in breadth from eaſt to weſt. Gough, in his additions to Camden's Britannia, eſtimates its length at forty-nine miles, and its breadth at thirty-ſeven. Its circumference, according to the ſame author, is one hundred and fifty miles, and the number of acres it contains 876,000. Mr. Davis, whoſe authority on this ſubject is highly reſpectable, in his Agricultural Report on the County, ſtates it to be in length fifty-four miles, and in breadth thirty-four. The ſame writer computes the ſuperficial area to be 1372 ſquare miles, or 878,000 acres.

The county of Wilts is a diſtrict peculiarly intereſting to the topographer and antiquary. To the latter, indeed, it offers a wider and more varied field for reſearch than perhaps any other county in England. The grand and myſterious monuments of Stonehenge and at Avebury, and the numerous barrows which cover its plains, are relics of an age anterior to hiſtorical record, and of which the annals of the world do not furniſh a parallel example. Like the proud pyramids of Egypt, the former were calculated by their conſtruction to have remained entire to almoſt endless futurity, if the agency of the elements had not been aſſiſted by the deſtructive influence of man. In the Wanſdyke, Bokerly-ditch, and Grimſditch, and in the ſimpler intrenchments with which the county abounds, we behold the remains of Britiſh towns, and perceive the mode adopted by the Britons to mark boundaries and form communications. The caſtles of Old Sarum, Scratchbury, Battlesbury, and Bratton, diſplay the efforts of a more advanced period; and many other of the Wiltſhire intrenched works bear marks of ſucceſſive occupation by the Romans, the romanized Britons, the Saxons, and the Danes. This part of the kingdom, indeed, ſeems to have been the principal theatre of the military and civil events which were conſequent on the Saxon and Daniſh invaſions. Here the far-famed Arthur and the ſtill more illuſtrious Alfred contended at different periods for the liberties of their country, and checked for a time the tide of invading conqueſt. At Ludgerſhall, Devizes, Malmsbury, and Marlborough, the veſtiges of Norman fortrefſes may yet be traced; and in Clarendon-park ſtood a ſumptuous palace, erected by king John. Malmsbury yet preſerves the ruins of a magnificent abbey; and in the cathedral of Saluſbury, we behold an edifice ſurpaſſing every ſimilar ancient ſtructure in uniformity of ſtyle and ſymmetry of parts. Many of the parochial churches in the county are alſo objects worthy the examination of the antiquary, as ſpecimens of architectural ſkill and ſcience; and in Wilton-houſe, Longford-caſtle, Font-hill, Corſham-houſe, Bowood, Tottenham-park, Charlton-park, Stour-

head, and Longleat, we are preſented with manſions alike celebrated for magnificence and beauty of ſcenery, and for popular attractions to the connoiſſeurs and artiſts of the country.

At the period of the invaſion of our iſland by Julius Cæſar, a people called the Belgæ inhabited a portion of this county. The Hedui are ſaid to have occupied its north-ſiſtern diſiſion, near the ſource of the Avon and about Cricklade. Another diſtrict is mentioned by Carte, in his Hiſtory of England, as being ſubſequentlly poſſeſſed by the Carvili, ſo named from their prince Carvilius; but whether theſe people were ſome of the Belgæ, or a diſtinct tribe, does not appear. Other authors ſuppoſe that the Cangi inhabited the northern parts, if not at this era, at leaſt ſoon after it.

When the Romans, after the lapſe of nearly a century, from the final departure of Cæſar, again invaded Britain in the reign of Claudius (A.D. 44.), they found the political condition and relations of its ſeveral tribes very materially altered. The opinion of Camden, in his Britannia, is, that the Belgæ had ſubdued the whole of Wiltſhire, and alſo had poſſeſſed themſelves of all the territories of the Hedui.

It is very generally admitted, that the Belgæ were the moſt powerful people in the ſouth-ſiſtern diſiſion of England at the era of which we are now ſpeaking; and no doubt is entertained of their having occupied all the ſouthern diſtrict of this county, as far as the Wanſdyke, which is therefore designated by the appellation of 'The great Belgic Boundary.'

Under the Romans, Wiltſhire formed part of Britannia-Prima, and many ſtations, encampments, and other military veſtigia of that people can be traced in different parts of it.

Subſequent to the departure of the Romans, the earlieſt event of political importance which occurs in hiſtory relating to Wiltſhire is the maſſacre of three hundred Britiſh nobles, on the ſpot where Stonehenge is ſituated, by the orders of Hengiſt (leader of the firſt Saxon expedition to England), who had invited them here to a banquet under the pretence of effecting a reconciliation between the Britons and himſelf. The truth of this dreadful catastrophe, however, is extremely doubtful, as it does not appear to be mentioned by any of the Saxon writers, and ſeems to reſt ſolely upon the authority of Nennius, and a few of the Britiſh or Welſh bards, who were evidently intereſted in the propagation of ſtories calculated to excite feelings of enmity and revenge in the breaſts of their countrymen, againſt a people, once their allies, but afterwards their inveterate and barbarous enemies. Carte ſays, that this "ſtory was borrowed from Witkind, who relates it of the Thuringians, who were murdered by the Saxons on a like occaſion, and upon a ſignal given in the ſame words made uſe of by the Britiſh writers." Turner, in his Hiſtory of the Anglo-Saxons, regards it as an incident which can neither be authenticated nor diſproved; and Whitaker, in his Hiſtory of Mancheſter, aſſerts, that the conqueſts of Hengiſt never extended beyond the limits of Kent; a circumſtance which, if fully eſtabliſhed, would no doubt tend to invalidate our belief of the tranſaction. Hume, in his Hiſtory of England, calls it a ſtory "invented by the Welſh authors, in order to palliate the weak reſiſtance made at firſt by their countrymen, and to account for the rapid progreſs and licentious deſtroyations of the Saxons." About the year 520, Cerdic, founder of Weſſex, having received conſiderable reinforcements from Saxony, and cut off a body of Britons which had been diſpatched to intercept them, collected all his diſpoſable forces, and advanced to Mount Badon, Badbury-caſtle, a Britiſh poſt

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then considered of great strength and importance, on account of its commanding situation, and its proximity to the concurrence of the Roman roads, which intersect the north-eastern division of this county. The distinguished Arthur, who so long upheld the falling fortunes of his country, relieved the garrison with a large army formed under his own inspection: Cerdic, apprized of his intention, abandoned the siege, and waited the approach of the enemy. The conflict was severe; the genius of Arthur, however, ultimately prevailed over the superior science of the Saxon general, and the more steady conduct of his veteran troops. The subjugation of Wiltshire was not again attempted till the year 552, when warfare was once more renewed. Kenric, the son of Cerdic, and his successor in the West-Saxon monarchy, again passed the frontiers of his dominions, and threatened Sorbiodunum or Old Sarum.

The British army took a position to secure its safety, and fought with their usual intrepidity, but were defeated by the superior discipline of the Saxons. At "Baranbyrig," Barbury-castle, in the vicinity of Marlborough, another decisive battle was fought, in which the invaders were again the conquerors; and Wiltshire in consequence became incorporated in the kingdom of Wessex.

After several skirmishes, a decisive battle was fought at Wodnesbury, in which the usurper of Wessex was defeated. The Danes made a descent on the island in the thirty-second year of Egbert's reign, and effected great ravages in Wiltshire. King Alfred afterwards attacked the Danes near Wilton, and routed them; but elated by success, he incautiously suffered them to rally when they gained a victory.

Alfred engaged them in several battles with varied success, and ultimately compelled them to sue for peace, which was granted; yet in the following year, regardless of their recent engagements, they suddenly advanced to Chippenham, then a royal residence, and established themselves in that town. They had gained such considerable reinforcements, that the king, with a part of his army, retired into Somersetshire. Here he remained several months, occasionally falling out upon the enemy, destroying their magazines, and carrying off their provisions. Having mustered a considerable army, Alfred quitted his retirement, and advanced to Æthandune, where the Danish forces lay encamped, attacked them by surprise, and gained a complete victory. No other particular event occurred in Wiltshire until 976, when a synod was held at Calne, in which the respective rights of the regular and secular clergy underwent a solemn discussion: the secular clergy would not relinquish their pretensions; another council was, therefore, convened the same year at Amesbury, in which it appears the canons were unsuccessful.

The next historical occurrence in Wiltshire happened in 1003, when the towns of Wilton and Sarum were plundered and nearly burned to the ground by the Danish monarch.

In 1006 another army of Danes visited Wessex, and retiring to the coast through Wiltshire, when some of its natives attacked it in the vicinity of Kennet; the Saxons were, however, defeated, and purchased peace by submitting to the tribute called Danegelt.

England now remained tranquil five years, when in 1011 king Swein and his son Canute again landed on the south coast, and entering this county, levied heavy contributions on the inhabitants. King Edward at this time being indisposed at Corsham, his son Edmund took the field, and put the invaders to flight. An obstinate battle was fought, about this time, at "Scearstan," or Sherston, on the north-western verge of the county, by Edmund (who had just succeeded his father, Edward) against the Danes; the decision of the battle turned in favour of king Edmund by the

unexpected flight of Canute. Subsequent to the Norman Conquest, Wiltshire retained a considerable share of political interest.

In the year 1086, the conqueror held a great council at Sarum; "where," says Blackstone, "all the principal landholders submitted their lands to the yoke of military tenure, became the king's vassals, and did homage and fealty to his person." Thus was the feudal system formally introduced into this country.

Clarendon, in this county, is remarkable for the laws passed there in the reign of Henry II.; "whereby," says Blackstone, "the king checked the power of the pope and the clergy, and greatly narrowed the total exemption they claimed from the secular jurisdiction;" though the completion of his wishes was prevented by the murder of the proud and arrogant prelate, archbishop Becket. These laws are still familiar to the antiquary, by the appellation of the 'Constitutions of Clarendon.' At Marlborough, in 1267, Henry III. held a parliament, or a general assembly of the 'Estates of England,' to provide for "the better state of the realm, and the more speedy administration of justice;" and here were consequently enacted those statutes for the suppression of tumults, which have ever since been denominated, 'The Statutes of Marlbridge.' In the contests between the houses of York and Lancaster, the inhabitants of Wiltshire were conspicuous for their attachment to the fortunes of the Henries. Many of them were present at the battle of Tewksbury, an event which tended to fix the crown on the brows of Edward.

In the deplorable events of the 17th century, this county was equally distinguished. Many actions between the parliamentary and royal forces were decided within its boundaries; particularly at Malmesbury, at Ludgerhall, and at Round-a-way-hill, in the neighbourhood of Devizes. Wardour and Longford castles were alternately besieged and taken by both parties within one year.

The remains of antiquity in Wiltshire, first entitled to notice in a collective view, are the stupendous monuments at Avebury and Stonehenge, both of which are regarded as druidical temples. In these structures we are presented with the most wonderful works of a rude but powerful people; works in which the bodily strength of associated numbers, with the science and customs of their age, are strongly manifested, and which are calculated not only to excite the astonished gaze and amazement of the multitude, but also to rouse curiosity and awaken inquiry in the minds of antiquaries and historians. See AVEBURY, and STONEHENGE.

Next to these immense temples, because resembling them in relative magnitude, though totally dissimilar in kind, the Wanfdyke may properly claim attention. This vast earthwork, which is supposed to have originally intersected the whole country, is now only distinctly visible in detached places, throughout the range of hills to the south and west of Marlborough, where it still remains tolerably entire, and in one place is seen in a bold and connected line for the space of ten or twelve miles.

Barrows, or Tumuli.—Of corresponding antiquity to the monuments already named, are the artificial hillocks or mounds of earth which abound in this county, and which appear to have an intimate connection with those temples, as they are more numerous around Stonehenge and Avebury than in any other places. These memorials were undoubtedly appropriated to sepulchral purposes. By the researches of Mr. Cunnington, sir Richard C. Hoare's "Ancient Wiltshire," the Rev. James Douglas's "Nennia Britannia," and a few other enlightened antiquaries, we are
made

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made familiar with the contents of these sacred depositories. See **BARROW**, and **TUMULI**.

The Roman stations mentioned in the Itinerary of Antoninus, as being situated within the county, are three in number, *Sorbiodunum*, *Verlucio*, and *Cunetio*. The first of these is placed by all antiquaries at Old Sarum; but the situation of the other two has been much disputed. Camden fixes *Verlucio* at Westbury; *Horley*, at Lackham; and *Stukeley*, whose opinion is the most probable, in the neighbourhood of Heddington. *Cunetio* was formerly supposed by some writers to be at the village of Kennet, and by others at the present town of Marlborough; but it is now generally allowed to have been situated at a short distance east from the latter place, near the north-eastern boundary of Savernake forest. Besides these, the Romans had several other settlements in this county; particularly at Easton-Grey, at Wanborough, at Pitmead near Heytesbury, and at Littlecot, at each of which places tessellated pavements and other Roman remains have been found. Of the Roman roads which passed through Wiltshire, the principal was a continuation of the *Julia Strata*, which entering the county from Bath, left it near Hungerford on the east. The Fosse road branched off from the *Julia Strata* at Bathford, at the north-west corner of the county, where in many places it is still conspicuous. Several other roads connected *Sorbiodunum* with neighbouring stations; and of these, three are traced with considerable certainty: first, one which led to *Durnovaria*, or Dorchester; secondly, that to *Venta-Belgarum*, Winchester; and thirdly, another to *Vindonum*, or Silchester.

The numerous encampments and other intrenched earthen works with which Wiltshire abounds vary not only in size and shape, but in method of construction and peculiarity of situation. Some of these are doubtless the works of the Britons, others of the Belgæ, of the Romans, of the Saxons, the Danes, and the Normans. Many of them, however, have been in all probability successively occupied and altered by the armies of one or more of these nations, at different periods subsequent to their original formation. The immense fortifications of Old Sarum, Chisbury-hill, near Warminster, and Vespasian's camp, near Amesbury, constitute the most distinguished monuments in this class of antiquities.

Castles.—That this county, at an early period, contained a number of those baronial fortified structures, which are usually designated by the term castles, and which are supposed by several writers to have been first introduced by the Normans, is undoubted. Most of them, however, are now totally demolished, so that it is even difficult to ascertain their actual sites; and the rest have been so much altered in later times, as almost to efface every vestige of the original building. The more celebrated of these edifices, and those which most frequently occur in the ancient historians, are the castles of Marlborough, Devizes, Ludgershall, Wardour, Combe, and Malmsbury.

General Aspect.—In a geographical arrangement, Wiltshire may be said to be naturally divided into two portions, by an irregular range of hills, which extends transversely through the greater part of the county in a direction inclining from the north-east to the south-west. These districts are usually denominated South and North Wiltshire, and differ very materially from each other, not only in appearance, but in almost every distinguishing quality.

South Wiltshire, which claims priority of notice on account of its superior extent, forms the western division of a vast tract of chalk-hills, which extends into Hampshire, and having for its boundaries the rich lands of Berkshire, and

the extreme verge of the Marlborough hills on the north; the broken ground of Somersetshire on the west; the new forest of Hampshire on the south; and the heaths of Surrey and Suffex, together with the West Downs of the latter county, on the east. The surface of the higher downs, to use the words of Gilpin, is "spread out like the ocean, but it is like the ocean after a storm; it is continually heaving in large swells." In some parts, the hills assume the form of rotund knolls, and are separated by smoothly-sided hollows, which vary considerably both in depth and extent. At other places they range along for a short distance in connected ridges, shewing on one side of the range rather a rapid declivity, from the top of which, on the other side, the hills sink in irregular gradation, till at length they frequently shelve into a perfect flat. This effect, says Marshall in his "Observations on" what he terms "the Western District" of chalk hills, is of course more particularly distinguishable, "where the range of hills is narrow, *single*, than where a congeries of such ranges are crowded together disorderly." The whole of this district, generally speaking, is separated into two divisions, the one called Marlborough-Downs, and the other Salisbury-Downs or Plain.

The principal valleys in this division of the county lie along the banks of the rivers, the most remarkable of which diverge like irregular radii from the country around Salisbury and Wilton. These display rich meadow and corn lands, interspersed with seats and villages, and finely covered in various parts with plantations of wood.

North Wiltshire differs entirely from the southern division of the county in its general appearance. Instead of a constant series of "chalky waves," the aspect of this district, which extends from the verge of the Downs to the hills of Gloucestershire, is nearly that of a perfect flat; the few deviations from the ordinary level being so gradual as scarcely to be perceptible, on a cursory view. The country here is so close and well wooded, that when viewed from any of the surrounding hills, it appears like one vast plantation of trees. If examined in detail, however, it is found also to contain many extensive tracts of rich pasture land, situated on the banks of the Lower Avon and the Thames, and of smaller streams which flow into both of those rivers.

Rivers.—Wiltshire abounds with rivers, which either take their rise within the county, or on its immediate confines. Two of these, the Thames and the Lower Avon, are unquestionably important streams. All the others are much inferior both in extent and consequence; but several of them deserve to be particularly noticed, *viz.* the Upper or Salisbury Avon, the Nadder, the Willey, the Bourne, and the Kennet. See **THAMES**.

The Lower Avon rises in the hilly district of North Wiltshire, at a short distance from the town of Wootton-Basset.

The Upper Avon is formed by the confluence of several smaller streams, which take their rise among the hills near the centre of the county. The Kennet rises near Avebury, and running in an easterly direction, unites with the Thames at Reading. The Willey and the Nadder join their streams at Wilton, and unite with the Avon at Salisbury.

The *cheese* of North Wiltshire has long been deservedly celebrated; though for some time after it became the staple commodity here, it was sold in the London market as the manufacture of Gloucestershire. See **CHEESE**.

Waste Lands.—It is a common idea that the Wiltshire downs consist entirely of "waste land." This notion, however, is completely erroneous; for if the correct appropriation of land is to be estimated by its comparative utility

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in different conditions, the application of the grounds in the chalk district cannot be very easily improved, or materially altered for the better.

In North Wiltshire the number of common fields is very great, but none of them are of any considerable extent. It is subject of regret, however, that they should exist at all, as many of them are dispersed over the richest soil in the district; and if brought under regular cultivation would be extremely productive.

The chaces within Wiltshire are supposed to have been numerous formerly, but only three woodland districts now retain that peculiar appellation: these are Cranbourn-chace, Verditch-chace, and Albourn-chace. The first and second join each other, and occupy a long narrow tract of country on the southern confines of Wiltshire. There are three canals which intersect parts of this county: first, the Thames and Severn; secondly, the Kennet and Avon; and thirdly, the Wiltshire and Berkshire. See CANALS.

The *manufactures* of Wiltshire are various, and of great extent. Salisbury is noted for its flannels and fancy woollens; and besides carries on a considerable manufactory of cutlery and steel goods, which are probably superior in workmanship to any in the kingdom. Wilton was celebrated for a large manufactory of carpets, and Mere for another of fancy woollens; and in its neighbourhood a great quantity of linen is made, chiefly dowlas and bed-ticks. Broad cloths, kerseymeres, and fancy cloths, are the principal produce of the towns of Bradford, Trowbridge, Warminster, Westbury, Melksham, Chippenham, and all the adjacent towns and villages from Chippenham to Heytesbury. At Albourn is an excellent manufactory of cotton goods, of which fustians and thicksets form the most valuable portion. Swindon and its vicinity has been long famed for its manufactory of gloves.

Ecclesiastical and Civil Division and Government.—The whole of this county is situated in the province of Canterbury; and, with exception of the parish of Kingswood, is in the diocese of Salisbury. It comprehends two archdeaconries, Sarum and Wilts; the former comprising the deaneries of Salisbury, Amesbury, Chalk, Pottern, Wilton, and Wily; and the latter, with the annexed rectory of Minety, those of Avebury, Cricklade, Malmesbury, and Marlborough.

As in the other counties of England, the chief civil magistrates of Wiltshire are, the lord-lieutenant, the custos rotulorum, and the high sheriff; which last is elected annually, and whose official business is chiefly conducted by a deputy-sheriff. The other local members of government are, justices of the peace, mayors and bailiffs of boroughs, and a variety of subordinate officers. The acting magistrates are seventy-three, and the petty sessions for the county thirteen.

Wiltshire is comprehended in the western circuit, and sends thirty-four members to parliament, *viz.* two knights of the shire, two citizens for Salisbury, and two burgesses for each of the following boroughs; Chippenham, Calne, Cricklade, Devizes, Heytesbury, Hindon, Downton, Great Bedwin, Marlborough, Malmesbury, Ludgerhall, Westbury, Wilton, Wootton-Basset, and Old Sarum. At an early period the whole county was divided into twenty-nine portions, called *hundreds*; and these are again subdivided into two hundred and ninety-five smaller districts, called parishes; with parts of fourteen others. In the county is one city, Salisbury; and twenty-three market-towns, *viz.* Amesbury, Bradford, Calne, Chippenham, Cricklade, Devizes, Downton, Great Bedwin, Heytesbury, Hindon,

Ludgerhall, Malmesbury, Marlborough, Market-Lavington, Melksham, Mere, Swindon, Trowbridge, Warminster, Westbury, Wilton, and Wootton-Basset.

The government, provincial management, number, and state of the poor in this county, as laid before parliament in the year 1804, and published by authority of the house of commons, are detailed in the following particulars. It is stated, "that returns were received from three hundred and thirty-six parishes, or places, in the county of Wilts, in the year 1803; in 1785, the returns were from three hundred and thirty-six; and from three hundred and twenty-five, in 1776." It is then further stated, "that forty-one parishes, or places, maintain all or part of their poor in workhouses; the number of persons so maintained, during the year ending Easter 1803, was one thousand six hundred and seven; and the expence incurred therein amounted to 14,547*l.* 2*s.* 0½*d.*, being at the rate of 8*l.* 19*s.* 8*d.* for each person maintained in that manner. By the returns of 1776, there were forty workhouses capable of accommodating two thousand and seventy-nine persons. The number of persons relieved out of workhouses was forty thousand five hundred and eleven, besides four thousand five hundred and thirty-six, who were not parishioners. The expence incurred in the relief of the poor, not in workhouses, amounted to 113,888*l.* 17*s.* 9½*d.* A large proportion of those who were not parishioners appear to have been vagrants; and, therefore, it is probable the relief given to this class could not exceed 2*s.* each, amounting to 453*l.* 12*s.* 0*d.* This sum being deducted from the above 113,888*l.* 17*s.* 9½*d.*, leaves 113,435*l.* 5*s.* 9¼*d.*; being at the rate of 2*l.* 16*s.* 0*d.* for each parishioner relieved out of any workhouse. The number of persons relieved in and out of workhouses was forty-two thousand one hundred and twenty-eight, besides those who were not parishioners. Excluding the expence supposed to be incurred in the relief of this class of poor, all other expences relative to the maintenance of the poor amounted to 131,864*l.* 19*s.* 9¼*d.*, being at the rate of 3*l.* 2*s.* 7*d.* for each parishioner relieved. The resident population of the county of Wilts, in the year 1801, appears from the population abstract to have been one hundred eighty-five thousand one hundred and seven; so that the number of parishioners relieved from the poor's rate appears to be twenty-three in a hundred of the resident population. The number of persons belonging to Friendly Societies appears to be six in a hundred of the resident population. The amount of the whole total money raised by rates is 16*s.* 0¾*d.* per head on the population. The amount of the whole expenditure on account of the poor appears to average at 14*s.* 3½*d.* per head on the population. The expenditure in suits of law, removal of paupers, and expences of overseers, and other officers, according to the present abstract, amounts to 3682*l.* 15*s.* 0*d.* The amount of such expenditure, according to the returns of 1785, was then 2501*l.* 13*s.* 9*d.* The expenditure in purchasing materials for employing the poor, according to the present abstract, amounts to 849*l.* 8*s.* 7½*d.* The amount of such expenditure, according to the returns of 1785, was 434*l.* 11*s.* 9*d.* It does not appear from the returns received, that the poor of any parish or place in this county are farmed or maintained under contract. The poor of six parishes are maintained and employed under the regulations of special acts of parliament. Thirty-six Friendly Societies have been enrolled at the quarter-sessions of this county, pursuant to the act of 33 & 35 Geo. III."—*Beauties of England and Wales, Wiltshire*, by J. Britton, F.S.A. 8vo. 1814. *Ancient Wiltshire*, by sir Richard C. Hoare, bart., folio, 1815.

WILTSHIRE or *Eleven-shared Plough*, in *Agriculture*, an implement of this kind invented and used in that district. In Oxfordshire it is employed for many different purposes; as for cleaning the land, and with shares contrived for furrowing the land previous to sowing. The crops principally sown, or put in after the use of this implement, are those of tares or vetches and turnips. See PLOUGH.

WILZ, in *Geography*, a town of France, in the department of the Forests; 6 miles N.W. of Dicrich.

WILZBURG, a fort of Germany, in the principality of Anspach; 23 miles S.E. of Anspach.

WIMACOMACK, a town of New York, in Long island; 44 miles E. of New York.

WIMBA, or WINIPA, a town of Africa, on the Gold Coast; 20 miles S.W. of Acra.

WIMBLE, in *Rural Economy*, a term provincially made use of to signify a boring auger. See AUGER.

WIMBLETON, in *Geography*, a village of England, in the county of Surrey; supposed by Camden and others to be the place where Ethelbert king of Kent was defeated by Ceaulin king of the West Saxons. According to history, the battle was fought in the year 586, at Wibandune. At the south-west corner of Wimbledon common is a circular encampment, with a single ditch, containing a space of about seven acres; 9 miles S. of London.

WIMBORNE or WINBOURNE *Minster*, a market-town of remote antiquity, in the hundred of Badbury, Shafton division of the county of Dorset, England, is situated on the river Allen, near its confluence with the Stour, at the distance of 28 miles E.N.E. from Dorchester, and 100 miles S.W. by W. from London. It was called by the Romans *Vindogladia*, alluding to its situation on a river. The appellation of *Wimbourne* is Saxon, derived from *Bourne*, a vale, and *Wim*, a small river which flows near the town. The term *Minster*, from the church, was added to distinguish it from other places of the same name. Camden states this town to have been a place of great consequence in the Saxon times, and that it then retained many marks of Roman grandeur. The present appearance indicates no vestiges of its former prosperity: though large and populous, it has little to recommend it to notice; the streets being irregular, and the houses deficient in uniformity. The trade carried on is chiefly confined to the woollen manufactory and the knitting of hosiery. The great object whence *Wimborne* derived its ancient reputation, and to which it is solely indebted for its modern celebrity, is the Nunnery, which was founded among the earliest of its kind in the kingdom. It was erected, as *Leland* informs us, in the beginning of the eighth century, by *St. Cuthburga*, daughter of *Kenred*, and sister of *Ina*, king of the West Saxons. In the reign of *Edward the Confessor*, or of one of the *Edwards* his predecessors, this edifice having been destroyed by the Danes, the establishment was dissolved, and converted into a college of secular canons, consisting of a dean, four prebendaries, three vicars, and other inferior officers. This college subsisted till the year 1547: on the dissolution the revenues were vested in the crown. Great part of the lands was granted to *Edward*, duke of *Somerfet*; and part was by queen *Elizabeth* vested in the corporation of the college towards the foundation of a grammar-school. In the reign of *Charles I.* all the possessions of the church and school were granted, in trust, to twelve governors, who, among other conditions, were to find for the service of the collegiate church three priests, three clerks, and subordinate members. This establishment, with some temporary obstructions, has been kept up ever since. The revenues at present amount to between

three and four hundred pounds. The church merits particular notice for its age and venerable appearance, and for the peculiarities of its architecture. *Mr. Gilpin* says, its form dates its antiquity, being of the heaviest and earliest Saxon style. *Dr. Stukeley*, however, and other antiquaries, were of opinion, that the eastern tower, and most part of the church, were built soon after the Conquest. Many parts are of early Norman architecture, particularly the femicircular arches in the eastern tower, the false windows in the south transept, and several others. The church is cruciform, with two quadrangular towers, one standing on the middle of the roof, and the other at the west end; the former was anciently ornamented with a spire, said to be of an extraordinary height. The whole edifice consists of a chancel, nave, choir, and side aisles, a transept, and three porches. Its length, from east to west, is 180 feet. Both chancel and choir are supported by eight pillars, over which are five windows on the north and three on the south side. The nave is supported on each side by six massy pillars of an irregular form, above which are pointed arches, with zig-zag mouldings: the whole enlightened by a similar number of windows, apparently of a more modern style. Many royal and noble persons have been interred in this church, most of whom were anciently commemorated by suitable monuments. Of these time has destroyed many, and the hand of violence more. Among those remaining, the most conspicuous is that of king *Ethelred*, who, as the inscription states, was slain by the Danes April 23, 872. This tomb stands in the choir on the north side of the altar. On the opposite side is that of the duke and duchess of *Somerfet* (parents of *Margaret*, countess of *Richmond*, mother of *Henry VII.*), with their effigies in alabaster. Within this church were once standing ten altars for the celebration of divine service, all of which were composed of alabaster and other costly materials, and suitably ornamented. The furniture of the high altar was particularly splendid; consisting of a variety of crosses and images, and other objects of worship, of silver-gilt, and adorned with precious stones.

Exclusive of the church, the public buildings of *Wimborne* are few and uninteresting. The town-hall was suffered to fall to decay; near its site is an open space, called the Square. Here are two meeting-houses for Presbyterians and Anabaptists; and a large commodious workhouse. Two annual fairs are held, and a weekly market on Fridays. The north part of the town has been long styled a borough, and consists of two streets, *East Borough* and *West Borough* streets. It was never incorporated, but is governed by two bailiffs annually chosen. The south part of the town, including all that is not in the borough, composes the tything of *Wimborne Minster*. The population of the whole, by the return of the year 1811, was enumerated at 3158; the houses at 701. About a quarter of a mile from the town is an hospital, or alms-house, with a chapel adjoining, called *St. Margaret's* hospital. The time of its foundation is entirely unknown; but by several curious deeds preserved in the chapel, it appears to be at least as old as the time of king *John*, when it was set apart for the relief and support of poor persons afflicted with the leprosy. It does not appear to have had any endowment, but to have been supported by voluntary donations, for which pope *Innocent IV.*, in the year 1245, granted special indulgences. Since the year 1688, the alms-people are not required to have the original qualification of leprosy, but only to be poor aged people. A second hospital, or alms-house, was founded and endowed by *Gertrude Courtney*, marchioness of *Exeter*, for the maintenance of six poor men and women; and a patent

was procured from queen Elizabeth for incorporating the "governor and poor persons:" they were invested with a common seal and other corporate privileges. But notwithstanding this parade, the charity has dwindled to nearly nothing; the six persons now on the foundation having only each a room, and the poor pittance of fifty-two shillings yearly.—Hutchins's History of Dorsetshire. Beauties of England and Wales, vol. iv. Dorsetshire. By J. Britton and E. W. Brayley.

WIMBREL, in *Ornithology*, the English name of a bird of the curlew kind, the *scelopax phaeopus* of Linnæus, and known among authors by the name of *arquata minor*, or the lesser curlew, and called in the Venetian markets *taraniola*.

It is much of the shape of the common curlew, but is not more than half its size. Its beak is about three fingers' breadth long, dusky above and red below; its feet are greenish; the feathers on the head and neck brown tinged with red, marked in the middle with an oblong black spot; the upper part of the back, coverts of the wings, scapulars, and farthest quill-feathers, of the same colour with the neck, but the black spots spread out transversely on each web; the quill-feathers dusky, their shafts white, and their exterior webs marked with large femicircular white spots; the breast, belly, and lower part of the back, are white; the coverts of the tail are of a pale whitish-brown, crossed with black bars. Its haunts and food are much the same with those of the curlew, but it is much less frequent on our shores. Pennant.

WIMES, in *Geography*, a town of France, in the department of the straits of Calais; 9 miles S.S.W. of St. Omer.

WIMMERBY, a town of Sweden, in the province of Smaland; 62 miles N. of Calmar.

WIMMIS, a town of Switzerland, in the canton of Berne, on the Sibuen; 18 miles S. of Berne.

WIMPEL, of the Dutch *wimpel*, a muffler, a plaited linen cloth, which nuns wear to cover their necks and breasts. The word is also sometimes used for a streamer, or flag.

WIMPFEN, in *Geography*, a town of Germany, on the Neckar, near which it is joined by the Jaxt. This place consists properly of two towns, the most considerable of which is called Wimpfen-auf-dem-berg, or Wimpfen on the hill; and the other Wimpfen-in-thal, or Wimpfen in the vale. In the former of these are a Lutheran parish-church and a grammar-school, as also a Roman Catholic hospital; but in the latter is a Roman Catholic abbey, with a convent of monks. The magistrates here are wholly Lutherans. The Huns are said to have ravaged this town; but an instrument of donation by king Henry VII. bearing date in the year 1228, shews it to have entirely recovered from that calamity. On the failure of the dukes of Swabia, it gradually procured its freedom, and the emperors Charles IV. and Wenceslaus promised to maintain it in its immediate dependency on the empire. In the years 1645 and 1688, it was taken by the French. In 1802, it was given to the duchy of Baden; 8 miles N. of Heilbronn. N. lat. 49° 15'. E. long. 9° 15'.

WIN, at the beginning or end of the names of places, signifies that some great battle was fought, or a victory gained there. The word is formed from the Saxon *winnan*, to win, or overcome.

WINANDER MERE, or *Winder Mere*, in *Geography*, a lake of England, in the county of Westmoreland, in which is an island, with a village. This is one of the largest lakes in England, being 15 miles long, and two broad, and from 90 to 200 feet deep, well furnished with fish of several sorts, VOL. XXXVIII.

but especially char; 17 miles S.S.E. of Kewick, and 270 N.N.W. of London.

WINBERG. See WINTERBERG.

WINCANTON, or WINCAUNTON, a market-town in the hundred of Norton-Ferris, and county of Somerset, England, is situated on the western slope of a hill near the river Cale, at the distance of 108 miles W. by S. from London. It is a place of remote antiquity; and was probably occupied by the Romans, as numerous coins of that people were discovered here in the early part of the last century. The Saxons were long in possession of it; and it is recorded in Domesday-Book to have been held by one Elfi in the reign of Edward the Confessor; but when William came to the throne he gave it to Walter de Dowcri. It afterwards passed to the Lovels, lords of Castle Cary, and through the families of St. Maur and Zouch, till by attainder it passed to the crown, 1 Henry VII., who granted it to Giles, lord Daubery. The town, in its present state, consists of four principal streets. A fire which occurred in 1747 opened a way towards the improvement of the buildings. The turnpike-road from Taunton to Salisbury runs through it. A considerable market is held on Wednesdays for cheese, butter, pigs, and flax-yarn for the linen manufactures, which are chiefly those of dowlas and ticking, in which most of the poorer inhabitants find employment. Here are also three annual fairs. The town-hall is a respectable brick structure, with a rustic stone basement: here is likewise a small old market-house, with a few shambles. At the west end of the town, in the road to Castle Cary, is a stone bridge of two arches over the Cale: there is another of one arch over the same stream in the road to Bruton. Wincanton church is a spacious edifice, and consists of a nave, chancel, and two aisles. The church is ancient; but the chancel was rebuilt, and the church new-roofed and windowed in the year 1748. At the west end is a plain square tower. The parish extends nearly seven miles from north to south, and three miles from east to west: it includes, besides the town, five small hamlets. The population return of the year 1811 states the whole to contain 380 houses, and 1850 inhabitants. Within this parish, at the distance of about three miles north-east from the town, are the remains of the priory of Stavordale, founded in the reign of Henry III., by Richard Lovel, then lord of the manor, for canons of the order of St. Augustine. The priory is now converted into a farm-house and barn, in which several arches and other parts of the original structure still remain.—Collinson's History of Somersetshire, vol. iii. 4to. 1791.

WINCH, a popular term for a windlass.

WINCH also denotes the crooked handle for turning round wheels, grind-stones, &c.

WINCH, a small windlass, with an iron axis, hung in rhodings or gudgeons, abast some vessels' masts to hoist the main-sail, &c. with a conical piece of timber at each end without the cheeks. It is hove round by two iron handles, formed by cranks or winches, from whence it takes its name.

WINCHES, the large iron handles by which the main-pumps in ships are worked.

WINCH, used by rope-makers, is made of wood, having four spokes at each end, connected together by four blades, to form the body. Through the centre of the spokes is a hole to receive an iron bolt, on which it turns by a handle in one of the spokes. Its use is to wind the yarn on as it is spun.

WINCH, to twist or make spun-yarn with, is similar to the former, but much less. The motion given to this winch is by the hand in twirling the yarn: on the edges of the spokes is a small iron hook to stop the yarn in twirling,

after which the spun-yarn is wound round the body of the winch.

WINCHCOMBE, in *Geography*, a market-town in the lower division of the hundred of Kiftsgate, Gloucestershire, England, is situated on the Cotswold-hills, 15 miles N.E. by E. from the city of Gloucester, and 95 miles W.N.W. from London. It was anciently a town of considerable importance, was written Wincelcumbe in *Domesday-Book*, and was there styled a borough when only Gloucester and Bristol, in the same county, were dignified with that title. It was the scite of a castle, and of a mitred abbey sufficiently capacious for the reception of 300 monks; but every vestige of these buildings has long been levelled with the dust, and the places where they stood are only conjectured. By whom the castle was erected is unknown; but the abbey was founded in 798, by Kenulph, king of Mercia, and was consecrated with great solemnity in the presence of three kings, and a great number of prelates and nobles. Being destroyed by the Danes, it was rebuilt in 981 by Oswald, bishop of Worcester, who converted it into a college of seculars, and restored it to great splendour. It was largely endowed; and in the reign of the Conqueror nineteen manors in this county were annexed to it, independently of Winchcombe itself. In 1265 its abbot was summoned to parliament, and the privilege was continued to all the succeeding abbots. The twenty-eighth abbot, Richard Ancelme, surrendered his abbey and its possessions to Henry VIII. in 1539. The edifice was soon after totally destroyed. Tradition reports it as very magnificent; but no description of it is now extant. Winchcombe, with a small territory adjoining, is said to have been, in the Anglo-Saxon time, a sheriffdom or county of itself; but in the reign of Canute, it was divested of its independence, and annexed to Gloucestershire. The town now consists chiefly of two streets, intersecting each other; the houses are low, and principally of stone. The difficulty of approaching it, through the badness of the roads, has prevented it from being much visited; but the new turnpike-roads have now opened a short and easy communication. The church is a spacious structure, with a nave, chancel, two aisles, and an embattled tower: the body of the church is also ornamented with battlements and pinnacles. The old church stood at the west end of the town; but having fallen to decay, the present fabric was begun in the reign of Henry VI. by the abbot, William Winchcombe, who completed the east part: the remainder was finished by the parishioners, assisted by the munificence of Ralph Boteler, lord Sudeley. The government of the town, which is a borough by prescription, is vested in two bailiffs and ten assistants; from the latter, the bailiffs are annually chosen. A weekly market is held on Saturdays, and here are three annual fairs, which are well attended; but from the reclusive situation of the town very little trade is carried on, a paper-mill and a tan-yard being the chief sources of employ. The workhouse is an ancient irregular building, in which the poor are employed in spinning and weaving linen. Here are also an alms-house for twelve poor women, and three charity-schools. The population of the town in the year 1811, according to the return to parliament, was 1256, occupying 299 houses: the parish extends twelve miles in circumference, and includes nine hamlets; the enumeration of the whole was 461 houses, and 1936 inhabitants.

About a quarter of a mile to the south-east of the town are the ruins of Sudeley-castle, erected by Ralph, lord Boteler, an eminent statesman in the reign of Henry VI., on the scite of a more ancient castle which appears to have been the residence of Herald, son to Radulf, earl of Hereford, in the time of the Norman conqueror. In this family, which assumed

the name of Sudeley, the manor continued till the 41st of Edward III., when it was conveyed by marriage. Sudeley was attached to the crown till the reign of Edward VI. when it was granted to sir Thomas Seymour, who settled here with Catharine Parr, the queen-dowager, whom he had married, and who died here in child-bed, not without suspicion of poison. Seymour being afterwards attainted, Sudeley was granted to William Parr, marquis of Northampton, who forfeited it soon afterwards. It now belongs to the marquis of Buckingham. Of this once-famed fortress, very little remains: parts of towers, the hall, and the chapel, serve to shew the style of architecture and character of the buildings.—See Williams's *History, &c. of Sudeley Castle*, folio. Also *Beauties of England and Wales*, vol. v. by J. Britton and E.W. Brayley.

WINCHELSEA, a borough and market-town on the coast of Suffex, England, situated about 3 miles W. from Rye, 8 E. from Haltings, and 67 from London. It is a member of the Cinque Ports, and an incorporated town, the officers of which consist, according to its charters, of a mayor and twelve jurats; but these are seldom composed of more than four or five persons. Winchelsea is a place of antiquity; but by the ravages of the sea, the scites of its houses, at different periods, have totally changed. The epoch of the rapid though gradual overthrow of the original town is fixed by Leland between 1280 and 1287. During that time the inhabitants petitioned Edward I. for ground to found another town, who accordingly granted them the scite of the present town, which he surrounded with walls, and to it the inhabitants gradually removed. The new town afterwards fell into decay, from a cause just the reverse of that which ruined the old; for the sea deserted its neighbourhood, and left in its place a dreary marsh. This began to be sensibly felt in the end of the reign of queen Elizabeth. The channel leading to the harbour was choked, the coast was deserted, and the town, abandoned by the trader, soon declined. The houses and churches fell to ruin, so that a town, once covering a surface two miles in circuit, is now reduced to comparatively a few houses in a corner of its ancient scite, now a mile and a half from the sea. Of the ancient church, the lofty and spacious chancel, now used for divine service, and three aisles, alone remain entire. In it are two monuments, with effigies of knights templars. Some fragments of the walls and of three gates of the town still exist. From the situation of Winchelsea, and the spacious vaults frequently discovered, it is probable that the town was the principal mart for French wines, imported into England before the wine-trade with Portugal was established. Winchelsea sends two members to parliament, who are elected by about forty freemen. The houses in this parish, in 1811, were 126, containing 131 families, and 652 persons.—*Beauties of England*, vol. xiv. 8vo. 1813, Suffex, by F. Shoberl.

WINCHELSEA *Island*, an island in the Pacific ocean; 30 miles S.E. of sir Charles Hardy's island.

WINCHENDON, a town of the state of Massachusetts, in the county of Worcester, with 1173 inhabitants; 56 miles N.W. of Boston.

WINCHESTER, an ancient and eminent city in Hampshire, or the county of Southampton, in England, 11 miles N.N.E. from Southampton, and 62½ W.S.W. from London. The buildings are disposed on the eastern declivity of a low hill, which gently slopes to the valley of the river Itchen, the chalky cliffs of which, and the chalky soil of the surrounding heights, in the opinion of Camden, occasioned the ancient name of the city, *Caer-Gwent*, signifying the 'white city.' The latter portion of the name, under

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under the Romans, became *Venta*, with the addition of *Belgarum*, from its situation in the country occupied by the *Belgæ*, by which it was distinguished from *Venta Silurum*, now Caerwent, in Monmouthshire, and *Venta Icenorum*, now Caistor, near Norwich, in Norfolk. From *Gwent* or *Venta* we have the first part of the name, and *chester*, the last part, is a corruption of *castra*, the Roman term for encampments of different kinds; a frequent name, or appendage of a name, of various places in England, and perhaps invariably an indication that such places owe both their origin and their primitive form to the military stations of the earliest conquerors of Britain.

Historic Events.—The origin of Winchester, remote as it unquestionably is, has been carried back to an epoch far beyond belief, even a century and half anterior to the foundation of Rome. Without referring to such remote and uncertain time, we may safely infer that this spot was occupied by the Belgæ, a Germanic tribe, who passing from Gaul, took possession of the country bordering the southern coast of England. (Cæsar's *Bel. Gal.* ii. 4.) Previous to their occupancy, it is conjectured that Winchester was the *Caer-Gwent*, or white city, of the aboriginal Britons. After the Romans had subdued the Belgæ and the Britons, they took possession of this town, and fortified it with ramparts and walls. These were disposed on the sloping side of a hill, and in the usual form of a parallelogram. Within this inclosure the town was constructed and arranged; and from the importance of this station, and its connection with other stations by military roads, there can be little doubt that *Venta Belgarum*, the Roman name, was a place of considerable importance. Among the antique relics of the Romans, which have been discovered at Winchester, are several coins, urns, &c.; also some fine coins of Caractacus, called the first British emperor. After the Romans left the island in 446, Gortheryn, or Vortigern, was elected chief of the western district, and he fixed his seat of government at Winchester. This town, as well as the whole island, was soon destined to experience a total change of polity, customs, and manners, by the introduction and domination of the Saxons in 519. On this occasion, the name of the city was changed from the British *Caer-Gwent* and the Roman *Venta* to another of equal import, *Wintan-cestre*, from which the modern name, Winchester, has gradually been formed. In 635 an important event occurred in Winchester, the arrival there of Birinus, deputed by pope Honorius to preach the gospel in those parts of the country still involved in paganism. Favoured by king Kinegils, Birinus's apostolic labours were eminently successful; for the king founded a new cathedral on the site of that destroyed under Diocletian, which was consecrated under his son and successor, Kenewalch, in 648. Egbert, king of the West-Saxons, succeeding in the subjection of all the other Saxon princes, was in 827 crowned king of all England in the cathedral of Winchester, thus created or considered to be the metropolis of the whole kingdom; and there, about 854, Egbert's successor, Ethelwolf, granted his famous charter, establishing a general system of tythes. About this period the commerce of the city is recorded to have greatly increased, and the principal inhabitants are stated to have constituted a guild, under the royal protection; the earliest association of the kind, by a century, recorded in history. During the greater part of this and the succeeding reign, the see of Winchester was filled by the celebrated St. Swithun, by whose advice king Ethelbald raised fortifications for the defence of the cathedral against the Danes. Landing at Southampton, they advanced to Winchester, where they committed horrible

excesses; but the cathedral escaped their fury. About 871, however, that greatly suffered by them, and all the clergy belonging to it were massacred. On the ultimate success of the great Alfred, Winchester resumed a portion of its former splendour; it became again the seat of government; there the public records of the kingdom were deposited, in particular the general survey, called, from this circumstance, *Codex Wintoniensis*, afterwards imitated by William the Conqueror in 1086, in the famous Roll of Winchester, or *Domesday-book*. (See *DOMESDAY*.) The succession of Edgar the Peaceable increased the importance of Winchester. Among the judicious laws which he established was one to prevent frauds arising from the diversity of measures used in the country, by providing a standard legal measure for the whole of his dominions. This was the origin of the established *Winchester measures*; the standard vessels for measurement made by Edgar's orders being deposited in that city, where the original bushel is still preserved. In the reign of this prince, in 980, the cathedral, having been partly rebuilt, was solemnly re-consecrated. About the same time the married canons of the cathedral were, at the suggestion of St. Dunstan, removed, to make room for Benedictine monks. In Winchester, in 1002, and in the reign of Ethelred, furnished the Unready, commenced the general massacre of the Danes, in merciless vengeance for the atrocities they had committed on the inhabitants of the country. Thence arose the noted *bock-tide sports*, of which some traces may still be observed in remote corners of England. But this vengeance remained not long unrequited by Swayne the Dane, who obtained possession of Winchester eleven years afterwards. St. Elphage II., then bishop, is said to have first introduced organs into the cathedral. Canute, obtaining the sovereignty of England by the death of Edmund Ironside in 1016, chose Winchester for his capital, and, with other rich gifts, bestowed on the cathedral his crown, which was placed over the crucifix on the high altar: for Canute had vowed never more to wear that ensign of royalty, from the day when, by commanding in vain the flowing tide not to approach his feet, he proved to his flatterers the emptiness of their adulation, in hailing him lord of the ocean. Winchester cathedral is described to have been the scene of a legendary tale relating to queen Emma, mother of Edward the Confessor, who is said, but very improbably, there to have established the purity of her character, by walking unhurt over nine burning plough-shares. In the reign of the same Edward, the broad seal of the chancellor of England was first made and kept in Winchester.

The Norman invasion produced many changes in the state of the city: there king William I. founded a castle, as he did in many other parts of the kingdom, with the view of overawing, under the pretence of protecting, the inhabitants. It continued, however, to be a principal royal residence, although London then began to assume the pre-eminence. The politic monarch knew the influence of the clergy over the people; he consequently assigned all or most of the chief offices in England to his relatives, dependants, and offensive friends. Councils were held in Winchester, in which the new clergy, with the primate Lanfranc at their head, drew up canons or laws levelled at the Saxons, and framed to protect or justify themselves. Winchester, the residence of the court, was of course filled with the priests, the officers, and the followers of the king. The curfew (*couvre-feu*), or eight-o'clock-bell, was first rung in Winchester. The year 1079 is memorable in the history of Winchester, for then was commenced the present spacious and magnificent cathedral church. In the reign of Henry I. a singular

transaction is recorded to have taken place in Winchester. The current coin of the realm having been greatly debased by the different mint-masters, the king in 1125 assembled them in this city, when all, except three who dwelt in Winchester, were found guilty and severely punished. The base money was cried down, and an entirely new coinage ordered to be made by the three masters who had preserved their honesty. About the same period Henry caused to be made a standard yard, from the length of his own arm, in order to prevent frauds in the measurement of cloth. This standard is supposed to have been deposited with other measures, &c. in Winchester. The city suffered greatly in the dissensions consequent on the death of Henry, by the struggle between his nephew Stephen and his daughter, the empress Matilda, or Maud. Stephen's party held the bishop's palace, the cathedral, and adjoining quarters, while Maud's possessed the castle and the remainder of the city. By fire from Stephen's party, the whole north portion, then the most populous, the royal palace, the abbey of St. Mary, and twenty churches, the magnificent monastery of St. Gribald, the suburb of Hyde, &c. were destroyed. Many privileges were conferred on Winchester by Henry II., in particular, in 1184, that of being governed by a mayor, with a subordinate bailiff. His successor, Richard Cœur-de-lion, was solemnly re-crowned in the cathedral in 1194, on his return from captivity under the duke of Austria. In the end of 1207 was born in Winchester Henry III.; and soon afterwards his father John, for the sum of 200 marks paid at once, and 100 marks *per annum*, conferred on the city all the great and unprecedented privileges of a corporation. Thus Winchester became the first of all the corporate cities or towns in the kingdom, nearly two years before London had even obtained the privilege of being governed by a mayor. The dignity of the city was in some measure restored by the residence of Henry III. during his minority; but it again severely suffered in the contests between the king and the barons. A heavy blow on Winchester proceeded from the removal of the royal residence, in the reign of Edward I.; who nevertheless held several parliaments there. Under Edward III. it was constituted one of the fixed markets, or staples for wool; but by the removal of the staple in 1363, the decline of Winchester from commerce and wealth was sensible and uniform. In this reign the rebuilding of the nave of the cathedral was begun by bishop Edington; but the honour of completing it, with material alterations, was reserved for his celebrated successor, William of Wykeham. To Winchester Henry VI. was a considerable benefactor; for in his reign it was so reduced in trade and population, that the inhabitants, in a petition to the king, represented 997 houses to be unoccupied, and 17 churches shut up. The see of Winchester was held for a short time by cardinal Wolsey; but in the time of his successor, Gardiner, the final dissolution of the monasteries, and the consequent destruction of religious houses, reduced the city to be little more than the skeleton of what it had formerly been. It revived for a short time in the reign of Mary, who there solemnized her union with Philip of Spain, and restored to the see many lands which had been alienated by her father and brother. The city itself, however, had, as appears by a charter of Elizabeth, fallen "into great ruin, decay, and poverty." The commencement of 1603 was distinguished by the proclamation of James I. in Winchester, by the sole authority of the sheriff of the county, without waiting for the orders of the privy council in London, who had passed several hours in deliberation on the subject. In the civil wars of Charles I.'s time, Winchester was successively held by the

opposite parties; but after the fatal battle of Naseby in 1645, it was finally reduced by Cromwell. The works of the castle were blown up, the fortifications of the city were destroyed, together with the bishop's castle of Wolvesey, and several churches, and other public buildings. During the latter part of the reign of Charles II. Winchester had a prospect of recovering some portion of its former splendour; for he chose it for his usual residence, when not required by presence in the capital. In imitation of his example, many of the nobility and gentry likewise erected mansions in the city; but by Charles's death in 1685, the project was laid aside; the palace was left unfinished; and so completely has its original destination since been changed, that, after being frequently used as a prison of war, it is now converted into military barracks for the district.

Fortifications: Palace.—The ancient walls of Winchester form an irregular parallelogram, inclosing a portion of the slope of the western hill, and of the level valley watered by the Itchen. But the walls are now nearly destroyed, and the foss in many places filled up. The four gates seemed to have been constructed where those of the Roman intrenchment were opened. Through two of them, on the north and south sides, passed the great Roman road communicating between *Vindonum*, now Silchester, and *Clautentum*, near Southampton. Through the gate in the west side of the inclosure, corresponding to the Prætorian gate of the intrenchment, ran the road communicating with *Sorbiodunum*, where now stand the remains of Old Sarum. This gate still exists, but much altered from its ancient state: part of it is supposed to be coeval with the city walls, but the whole western face displays workmanship of much later date. The east or Decuman-gate opened access to the lively and wholesome waters of the Itchen.

The castle, now entirely destroyed, overlooking the city from the west, owes its origin to the system of dominion adopted by William of Normandy. Within its boundary, of an elliptic form, 850 feet from north to south, and in its greatest breadth 250 feet from west to east, stands the original chapel dedicated to St. Stephen, and apparently erected by the king of that name. It is in length 110 feet, divided into a nave and side-aisles. At the east end is suspended the antique curiosity called king Arthur's round-table; but with more accuracy attributed to king Stephen, and probably introduced by him to prevent disputes for precedence, during their entertainments, among the chivalrous champions of that age. It is 18 feet in diameter, composed of stout oaken planks, painted with the figure of the renowned Arthur, and the names of his twenty-four knights, as collected from the romances of the 14th and 15th centuries. The costume is, however, of the time of Henry VIII., when the table was painted. This chapel was, in Cromwell's time, converted into a county-hall, a destination to which it continues to be applied. In the year 1792, several thousands of French ecclesiastics sought refuge on the British shores. In their destitute situation, they were generously succoured by the state and the people; and at one time one thousand of them were accommodated with lodgings, and all other necessaries, in this deserted abode of royalty.

Winchester possessed also another fortress at the opposite end of the city: this was Wolvesey castle, the episcopal residence erected by the powerful bishop Henry de Blois, brother of king Stephen.

Cathedral.—The grand object of attraction in Winchester is its cathedral, one of the most interesting structures of its kind in England, whether considered with respect to the antiquity of its foundation, to the importance of the transactions

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actions of which it has been the scene, or to the characters of the personages whose mortal remains it contains. This magnificent and venerable structure has been called, and not without some propriety, a school of ecclesiastical architecture; for it displays to the student an interesting and varied series of examples of the ancient architecture of England, from an early age down to a recent period. If the student fail to satisfy himself as to Roman remains, or genuine Saxon work; if, after careful examination, he retire either doubtful or persuaded that no such architecture is there to be discovered; still he will have ample evidence and examples of Norman works. The plans and magnificent designs of those proud invaders and innovators are in that fabric amply displayed. There he will see that the Normans built not for themselves only, but for posterity; that their edifices were solid and substantial, simple in their forms, and large in their parts; that as their system of religion was intended to awe, terrify, and soothe the mind, so its primary temple in England was calculated most essentially to promote those ends.

The cathedral of Winchester is of great extent, its extreme external length being 556 feet, that of the cross or transepts 230 feet; the external breadth of the whole body and choir 118 feet, and that of the transepts 88 feet. The body of the church is divided by ranges of clustered columns into a nave and two side-aisles, as are also the transepts, with the unusual addition of aisles at the extremities. The great central tower rests upon four piers of great solidity, and rises 140 feet from the pavement. The present fabric may be considered as the foundation of bishop Walkelyn, a chaplain and relative of William of Normandy, who began it in 1079, constructing the crypts, the transepts, and tower; also the internal parts of the piers and walls of the nave. The work was continued under succeeding prelates, in particular by bishop de Lucy, who built part of the east end; by Edington, who erected the west front about 1330; and above all by Wykeham, who, between 1370 and 1400, brought the nave to completion. The exterior of the cathedral presents but few beauties, or attractive features. Its length of nave, plainness of masonry, shortness and solidity of tower, width of east end, and boldness of transepts, furnish, however, so many peculiar and specific characteristics. The interior of the cathedral will amply compensate for any defects or deficiencies of the outside. While the fine and sublime architecture of Wykeham, in the nave and aisles, produces the most impressive effect, and claims general admiration; the large, plain, and substantial works of Walkelyn, in the tower and transepts, are simply grand and imposing. The transepts and tower are entitled to attention, as unrivalled specimens of Norman architecture. The choir and eastern end are elevated above the nave and aisles, by an ascent of several steps; the choir itself occupying the space mostly beneath the Norman tower, and fitted up with stalls of elaborate workmanship. On the north side stands the pulpit, curiously carved in the time of Silkeste, who became prior in 1498. On the same side of the choir is placed the organ, in an unusual situation, under one of the lofty arches of the tower. The choir is separated from the nave by a screen of the Composite or Roman order of architecture, said to have been designed by Inigo Jones. The lofty stone screen erected behind the high altar is an elaborate and sumptuous work, covered with niches, canopies, buttresses, pinnacles, crockets, pediments, &c.; and when in its original colour and condition, with statues and costly ornaments, must have been peculiarly splendid and beautiful. On entering the church by the west door, the attention is first arrested by the vast and lofty

columns of the nave, which have been made to assimilate with the pointed style, by surrounding them with clustered shafts and other ornaments. Between the fifth and sixth columns, on the south side, stands the chantry or mortuary chapel, containing the tomb of bishop William of Wykeham, erected in his life-time, or prior to the close of the year 1404. On an altar-tomb within the chapel is the marble effigy of the founder. On the same side of the nave is the chantry of bishop Edington, who died in 1366; within an open screen is an altar-tomb supporting his effigy. Immediately behind the altar-screen in the south aisle is placed the sumptuous chantry of bishop Fox, containing neither tomb, statue, nor inscription, to commemorate the founder, or to explain his works in the church. In a recess beneath is the effigy of an emaciated human figure, the head ornamented with a mitre, but the feet resting on a skull. Opposite to this chantry in the north aisle stands that of bishop Gardiner, who died in 1555. Towards the eastern extremity of the church are the chantries of cardinal-bishop Beaufort on the south side, and of bishop Waynflete, the munificent founder of St. Mary's college, Winchester, and Magdalen college, Oxford, on the north side; each containing the tombs and figures of the respective prelates. The eastern extremity of the church is terminated by the spacious Lady-chapel, with a smaller inclosed on each side. In the middle of the presbytery, between the choir and the altar, lies a coffin-tomb, said to cover the remains of William Rufus, who was killed while hunting in the New Forest, and buried in this cathedral in 1100. On the top of the side-screens, between the present choir and the aisles, are placed six wooden chests, the work of bishop Fox, containing memorials and relics of Saxon monarchs, princes, and other illustrious personages, former protectors and benefactors of the cathedral. Another object of undoubted antiquity is the curious font, now placed between two columns on the north side of the nave. It is a large square block of black marble, charged on each side with sculptures, the whole supported by small columns at the corners. The subject of the sculptures is a matter of dispute; and although as productions of art they are beneath criticism, yet as representations of costume, manners, implements, &c. they deserve particular attention.

Episcopal Castle, or Palace.—Of this structure, better known by the name of Wolvesey castle, the ruins shew it to have been an imperfect parallelogram of about 250 feet by 160. What still remains belonged to the keep. Much was removed to make way for the new palace erected by bishop Morley, under the superintendance of sir Christopher Wren, after its destruction by Cromwell. The front of Morley's palace was pulled down by the present bishop, who never occupies the present house.

College.—One of the most celebrated institutions of Winchester is the college, founded by bishop Wykeham, and completed in 1393, on the site of an ancient grammar-school; intending it as preparatory for his establishment of New college, Oxford. The establishment in Winchester consists of a warden, 70 scholars, 10 secular priests, who are perpetual fellows, 3 priests' chaplains, 3 clerks, 16 choristers, and a first and a second master. So judicious and complete were the statutes drawn up by Wykeham for the government of his college in Winchester, as to be adopted, with very little alteration, by Henry VI., for his own splendid institutions at Eton and King's college, Cambridge. On the confirmation, by Edward VI., of the general dissolution of colleges, &c. introduced by his father, Winchester college, with those of Eton and the universities, were specially excepted. The buildings of the college occupy a considerable extent of ground, and consist principally

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cipally of two courts, with a cloister. The entrance to the first court is under a spacious gateway, having the mutilated busts of a bishop and a king, to represent the founder and his royal patron, Edward III. The second court is also entered by a tower gateway. The chapel and hall form the fourth wing of the quadrangle, and are enlightened by lofty windows. The interior of the chapel has a fine and lofty vaulting, ornamented with tracery. In the centre of the cloister is the library, originally constructed for a chantry in 1430, but converted to its present use in 1627. In the south-west corner of the second court is the hall or refectory, between which and the passage to the chapel is the school, a plain brick building, erected by subscription in 1687; over the door is the statue of the founder in bronze, by Cibber.

City.—The present city of Winchester consists chiefly of one main street, extending from the west to the east, with a number of collateral streets and lanes branching off on each side. Towards the middle of the High-street stands the city cross, an elegant specimen of the style of the age of Henry VI., consisting of three stories adorned with open arches, niches, pinnacles, and small crosses. The ecclesiastical buildings in Winchester, and its suburbs, were once very numerous, and, according to some writers, amounted to upwards of ninety. Scarcely twelve now remain. St. Laurence's church, near the cross, is considered as the mother-church of the city, and by a solemn entry into it the bishop takes possession of his see; but the principal parochial church is now that of St. Maurice. The town-hall, or more properly the hall of the guild of merchants of Winchester, rebuilt in 1713, occupies the place of one erected about 1112. There the city archives, the original Winchester bushel of king Edgar, and other measures of length and capacity fixed as standards by succeeding princes, and various curious memorials of antiquity, are now preserved. The front of the building is ornamented with a statue of queen Anne. A neat market-house was erected in 1772. The ancient building on the north side of the High-street, called St. John's House, was originally founded as an hospital, apparently so early as in the 10th century; but falling into the possession or the administration of the knights templars, or of St. John of Jerusalem, it was on the suppression of their order granted by Edward II. to a citizen of Winchester, who refounded the institution for the sick and lame soldiers, pilgrims, and wayfaring men, to have their lodging and diet there gratis for one night or longer, as their inability to travel might require. At the general dissolution of hospitals and monasteries, the revenues and moveable property were seized by Henry VIII.; but the corporation of the city reserved the building itself to be used for municipal business. In 1554 it again became a charitable foundation, being endowed by Richard Lamb, esq. for the support of six widows. The principal chamber or hall, which is 62 feet in length, 38 in breadth, and 28 in height, has been handsomely fitted up, chiefly by a donation from the late colonel Brydges of Avington. Among the decorations of this hall, in which public feasts, music-meetings, and assemblies are held, is a whole-length picture of Charles II. by Lely, presented to the city by that king himself. In the adjoining council-chamber are suspended the city tables, as they are called, containing a chronological arrangement of the most remarkable occurrences relating to Winchester. The ancient chapel of the hospital is now used as a free-school. The celebrated monastery founded by the great Alfred, called the 'Newen Mynstre,' and afterwards Hyde abbey, occupied nearly the whole space between the cathedral and the High-street. Completed under his son Edward, it was first filled by canons regular, who, in 963, gave place

to Benedictine monks. Alwyn, the eighth abbot, with twelve of his monks, fell in the battle of Hastings, in supporting the cause of his nephew, Harold, which drew upon the abbey the vengeance of William of Normandy. But the position being unhealthy and inconvenient, a new and magnificent church and monastery were erected just without the north wall of the city, on the spot called Hyde-meadow, to which the monks removed in 1110, carrying with them the remains of several illustrious personages who had been buried in the former abbey, among which were those of Alfred himself and some of his descendants. The annual revenues of Hyde abbey, of which the abbot sat in parliament, were at the dissolution valued at 865*l.* 18*s.* The church and monastery were soon afterwards demolished, and even the tombs of Alfred and other eminent persons were despoiled. What now remains of this institution is the small and mutilated parish-church of St. Bartholomew. Precisely on the space occupied by the abbey-church was some time ago erected a bridewell, or house of correction, on the plan of the benevolent Howard. In digging the foundations, stone coffins, rings, and vessels for the service of the church, were discovered, together with fragments of architectural sculpture. But between fifty and sixty years ago, among the remains of the buildings, was found a stone with this inscription in Saxon characters, 'Alfred Rex DCCCLXXXI.' Another remarkable religious establishment in Winchester was the Nunna Mynstre, or abbey of St. Mary, founded by Alfred's queen, Alswitha, and the place of her retirement after his death. Scarcely any vestige of the conventual buildings now remain, excepting in a modern mansion built out of the ancient materials, and the name of the abbey still applied to the inclosure where it stood.

Winchester, besides the numerous churches of the establishment, contains meeting-houses for dissenters of various denominations, among which the principal building is the Roman Catholic chapel, rebuilt by Dr. Milner in 1792, on the foundations of one more ancient. A large and commodious county-gaol, from the designs of Mr. Money penny, has been lately erected on the north side of the city.

Many privileges have at various times been bestowed on Winchester by English sovereigns. Its chief magistrate, as was before noticed, received the title of mayor in 1184, some years before the title was granted to the chief magistrate of London. The first charter was conferred by king John; but that under which the city is now governed was the gift of Elizabeth, "in consideration," as it is stated, "of the city of Winchester having been most famous for the celebration of the natiivities, coronations, sepulchres, and for the preservation of other famous monuments of the queen's progenitors." By this charter, the government is vested in a mayor, recorder, six aldermen, a town-clerk, two coroners, two constables, and a council of twenty-four of the "better, discreeter, and more honest sort" of inhabitants. The first return of representatives to parliament for Winchester took place in the twenty-third year of Edward I. The right of election is vested in the corporation.

Winchester possesses very little trade but what arises from its situation in the centre of an extensive and populous county. An ancient wool-combing manufactory, however, is still in existence, and of late years the silk manufacture has been introduced. All the public business of Hampshire is transacted in Winchester, which occasions a frequent and ample influx of strangers from all quarters. The cathedral and the college secure to the city the residence of a number of superior clergy. When in the height of its prosperity, and possessing the benefit of the wool-staple, the wealth of the inhabitants was greatly increased by the multitudes

tudes resorting to its fairs, the principal of which was held on the neighbouring hills of St. Giles and St. Mary Magdalen. St. Giles's fair was, at one time, by far the greatest in England. By a grant from William the Conqueror, it was originally to be held for one day only; but by Henry II. its duration was enlarged to sixteen days; and in that time no mercantile business was permitted to be transacted in Southampton, nor in any other place within seven leagues of St. Giles's hill. This fair has long become very insignificant; that of St. Mary Magdalen is still, however, much frequented. Since the year 1770, various improvements have been made in the general appearance of the city, by paving, repairing, and cleansing. As early as 1736 was established in Winchester an hospital or infirmary for the county, a very useful institution, conducted on a plan judicious in itself, and honourable to those entrusted with its administration. According to the parliamentary returns of 1811, the number of houses composing the city and suburbs was 1134, and the inhabitants 6705.

Hospital of St. Cross.—About a mile south from Winchester, in the valley watered by the Itchen, stands the venerable hospital of the holy cross; an institution still retaining more of its original character. "The lofty tower," observes Dr. Milner, "with the grated door and porter's lodge beneath it, the retired ambulatory, the separate cells, the common refectory, the venerable church, the flowing black drefs, and the silver crosses worn by the members, the conventual appellation 'brother' with which they address one another, the silence, the order, the neatness, in short, that reign here, seem to recall the idea of a monastery to those who have seen one, and will give no imperfect idea of such an establishment to those who have not had that advantage." But this establishment was never a monastery, being only an hospital originally founded by bishop Henry de Blois, between 1132 and 1136, for the residence and maintenance of thirteen poor men, and the relief of a hundred others of the most indigent of the city, but of creditable character. Each of these was to be provided daily with a loaf of bread, three quarts of small beer, and two messes for his dinner, in a hall appointed for the purpose. In the hospital was an endowment for a master, a steward, four chaplains, thirteen clerks, and seven choristers. Before the time of William of Wykeham, bishop of Winchester in 1366, the revenues of St. Cross had been employed in a way very different from the intentions of the founder; but that munificent prelate succeeded, after long litigation, in restoring the institution to its original uses, re-establishing it on a secure and well-ordered foundation. The plan was afterwards resumed and enlarged by cardinal-bishop Beaufort, for the additional support of two priests and thirty-five resident poor men: he also rebuilt a considerable portion of the hospital. The present establishment of St. Cross is but the wreck of its ancient institutions, having been severely sinned, though not quite destroyed, like many other charitable establishments, at the Reformation. Instead of seventy residents, clergy and laity, entirely supported in the place, and one hundred out-pensioners, the institution at present consists of but ten residing brethren, and three out-pensioners, with one chaplain and the master. Certain doles of bread, it is true, continue to be distributed to the poor of the neighbourhood; and, as perhaps the only vestige remaining in the kingdom of the simple hospitality of ancient days, the porter is daily furnished with a certain quantity of good bread and beer, of which every traveller, or other person whatever, who knocks at the lodge and calls for relief, is entitled to partake gratuitously. The buildings of the hospital once composed two courts; but the south side of the interior quadrangle

has been of late years pulled down. On the east side of the outer court is the 'hundred-menne's hall,' about forty feet long, now converted into a brewhouse; on the south side is the handsome tower-gateway, with the statue of the founder, Beaufort, in the upper part. In the second, or inner court, is the church, built in the cathedral form, with a nave and transepts, and a low massive tower at their intersection. The architecture of the edifice is singularly curious, as it throws some light on the progress, if not on the origin, of the pointed, or English style. The whole edifice seems to be a collection of architectural essays, with respect to the form and the disposition, of both the essential parts and the subordinate ornaments. It presents the ponderous pillar of a height equal to its circumference, but supporting an incipient pointed arch. The lower part of the nave contains massive Norman pillars; and the portal of the west front is an elegant specimen of the time of king John, or beginning of that of Henry III. The west wing of the remaining buildings contains the apartments of the Brethren, each of whom has for his own use three chambers and a separate garden. Adjoining to the hall on the north side are the apartments of the master, which are spacious and convenient; and on the east side is the ambulatory or open portico for exercise.

St. Catherine's Hill, or College Hill, separated from the meadows of St. Cross by the branches of the Itchen, is remarkable for the intrenchment carried round its summit: the former name it acquired from an ancient chapel on it, deprived of its endowments by cardinal Wolsey; the latter, because it is a frequent place of resort for the students of the college.

About three miles north-east from Winchester is Avington, anciently Abyngton, a seat and manor of the present marquis of Buckingham, in consequence of his marriage with the sole daughter and heiress of James, the last duke of Chandos. The manor, originally a royal demesne, was granted, in 961, by king Edgar to the monastery of St. Swithun, in Winchester; but in consequence of the dissolution, it became, in the reign of Elizabeth, the property of the ancient family of Bruges, or Brydges, first settled in Shropshire at the Conquest. Inter-marrying with the family of lord Chandos, renowned in the wars in France under Edward III., the honours of the two families have ever since continued united. Avington is situated in a secluded valley, well planted and nearly inclosed by high downs. The present mansion is mostly of brick, and has been greatly improved by the present possessor, having been previously dismantled by the late duke, for the purpose of adding two wings. Some of the apartments are fitted up with great elegance, and enriched by a selection of excellent paintings. The park formed by the late duke, about three miles in circumference, contains a piece of water supplied by the river Itchen.—History, &c. of Winchester, by the Rev. John Milner, D.D. F.S.A., 2 vols. 4to. 2d edit. 1809. Beauties of England, vol. vii. Hampshire, by J. Britton and E. W. Brayley. History, &c. of Winchester Cathedral, by J. Britton, 1 vol. 4to. with 30 Prints.

WINCHESTER, a town of New Hampshire, in the county of Cheshire, with 1478 inhabitants; 13 miles S.E. of Chesterfield.—Also, a town of the state of Connecticut, in Litchfield county, with 1466 inhabitants; 22 miles N.W. of Hartford.—Also, a town of the state of Kentucky, with 4 churches, and 2000 inhabitants.

WINCHESTER, or *Fredericktown*, a town of Virginia; 56 miles W.N.W. of Washington. N. lat. 39° 15'. W. long. 78° 22'.

WINCING, in the *Manege*, is said of a horse when he kicks, spurs, or throws out his hind feet.

WINCKHEIM, in *Geography*, a town of the duchy of Wurzburg; 4 miles N.N.W. of Lauringen.

WINCRANTUM, in *Natural History*, a name given by the people of the East Indies to a fossil substance resembling, in some degree, the plated lead ores of Europe, but containing very little of that metal; it is properly a species of blende, or mock-lead, of a talcky appearance; it is considerably hard, and is usually found in other stones. It is given in medicine in the Indies as a provocative to venery, being first calcined and beat to powder.

WIND, VENTUS, a sensible agitation of the air, by which a large quantity of it flows in a current or stream out of one place, or region, into another. See METEOROLOGY.

The winds are divided into *perennial*, *stated*, and *variable*.

They are also divided into *general* and *particular*.

WINDS, *Perennial* or *Constant*, are such as always blow the same way.

Of these we have a very notable one between the two tropics, blowing constantly from east to west; called the *general trade-wind*.

WINDS, *Stated* or *Periodical*, are such as constantly return at certain times. Such are the sea and land breezes, blowing from sea to land in the evening; and from land to sea in the morning.

Such also are the *shifting* or *particular* trade-winds, which, for certain months of the year, blow one way, and the rest of the year the contrary way. See *TRADE-Winds*.

WINDS, *Variable* or *Erratic*, are such as blow now this, now that way; and are now up, now hushed, without any rule or regularity, either as to time or place.

Such are all the winds observed in the inland parts of England, &c. though several of these claim their certain times of the day. Thus, the *west* wind is most frequent about noon; the *south* wind in the night; the *north* in the morning, &c.

WIND, *General*, is such a one, as at the same time blows the same way, over a very large tract of ground, almost all the year. Such only is the *general* trade-wind.

But even this has its interruption: for, 1. At land it is scarcely sensible at all, as being broken by the interposition of mountains, valleys, &c. 2. At sea, near the shore, it is disturbed by vapours, exhalations, and particular winds, blowing from landward; so that it is chiefly considered as *general*, only at mid-sea: where, 3. It is liable to be disturbed, by clouds driving from other quarters.

WINDS, *Particular*, include all others, excepting the *general* trade-winds; which see.

Those peculiar to one little canton, or part, are called *topical* or *provincial* winds. Such is the north wind, on the western side of the Alps, which does not blow above one or two leagues lengthwise, and much less in breadth: such also is the pontias in France, &c.

WINDS, *Physical Cause of*. Some philosophers, as Des Cartes, Rohault, &c. account for the general wind, from the diurnal rotation of the earth, and from this general wind derive all the particular ones. The atmosphere, say they, investing the earth, and moving round it; that part will perform its circuit soonest which has the smallest circle to describe: the air, therefore, near the equator, will require a somewhat longer time to perform its course in, from west to east, than that nearer the poles.

Thus, as the earth turns eastward, the particles of the air near the equinoctial, being exceedingly light, are left behind; so that, in respect of the earth's surface, they move eastwards, and become a constant easterly wind.

This opinion seems confirmed by this, that these winds

are found only between the tropics, in those parallels of latitude where the diurnal motion is swiftest. But the constant calms in the Atlantic sea near the equator, the westerly winds near the coast of Guinea, and the periodical westerly monsoons under the equator in the Indian seas, declare the insufficiency of this hypothesis.

Besides, the air, being kept close to the earth by the principle of gravity, would, in time, acquire the same degree of velocity that the earth's surface moves with, as well in respect of the diurnal rotation, as of the annual, about the sun, which is about thirty times swifter. See *TRADE-Winds*.

Dr. Halley, therefore, substitutes another cause, capable of producing a like constant effect, not liable to the same objections, but agreeable to the known properties of the elements of water and air, and the laws of the motion of fluid bodies. Such a one is the action of the sun's beams upon the air and water, as he passes every day over the ocean, considered together with the quality of the soil, and the situation of the adjoining continents.

According to the laws of statics, the air, which is less rarefied or expanded by heat, and consequently is more ponderous, must have a motion towards those parts of it which are more rarefied, and less ponderous, to bring it to an equilibrium; also, the presence of the sun continually shifting to the westward, that part towards which the air tends, by reason of the rarefaction made by his greatest meridian heat, is, with him, carried westward; and, consequently, the tendency of the whole body of the lower air is that way.

Thus a general easterly wind is formed, which being impressed upon the air of a vast ocean, the parts impel one the other, and so keep moving till the next return of the sun, by which so much of the motion as was lost is again restored; and thus the easterly wind is made perpetual.

From the same principle it follows, that this easterly wind should, on the north side of the equator, be to the northward of the east, and in south latitudes to the southward of it; for, near the line, the air is much more rarefied than at a greater distance from it; because the sun is twice in a year vertical there, and at no time distant above $23\frac{1}{2}$ degrees; at which distance, the heat, being as the sine of the angle of incidence, is but little short of that of the perpendicular ray; whereas under the tropics, though the sun stay longer vertical, yet he is a long time 47 degrees off, which is a kind of winter, in which the air so cools, as that the summer heat cannot warm it to the same degree with that under the equator. Wherefore, the air towards the north and south being less rarefied than that in the middle, it follows, that from both sides it ought to tend towards the equator.

This motion, compounded with the former easterly wind, accounts for all the phenomena of the general trade-winds, which, if the whole surface of the globe was sea, would undoubtedly blow quite round the world, as they are found to do in the Atlantic and the Ethiopic oceans. But seeing that so great continents do interpose, and break the continuity of the ocean, regard must be had to the nature of the soil, and the position of the high mountains, which are the two principal causes of the variations of the wind from the former general rule; for if a country lying near the sun prove to be flat, sandy, and low land, such as the deserts of Lybia are usually reported to be, the heat occasioned by the reflexions of the sun's beams, and the retention of it in the sand, is incredible to those who have not felt it; by which the air being exceedingly rarefied, it is necessary that the cooler and more dense air should run thitherwards, to restore the equilibrium. This is supposed to be the cause, why,
near

WIND.

near the coast of Guinea, the wind always sets in upon the land, blowing westerly instead of easterly, there being sufficient reason to believe that the inland parts of Africa are prodigiously hot, since the northern borders of it were so very intemperate, as to give the ancients cause to conclude that all beyond the tropics was uninhabitable by excess of heat.

Mr. Clare, in his *Motion of Fluids*, p. 302. mentions a familiar experiment, that serves to illustrate this matter, as well as the alternate course of land and sea breezes. Fill a large dish with cold water, and in the middle of it place a water-plate, filled with warm water: the first will represent the ocean, the other an island, rarefying the air above it. Then holding a wax-candle over the cold water, blow it out, and the smoke will be seen, in a still place, to move toward the warm plate, and rising over, it will point the course of the air (and also of vapour) from sea to land. And if the ambient water be warmed, and the plate filled with cold water, and the smoking wick of a candle held over the plate, the contrary will happen. (See BREEZE.) For the phenomena of the wind observed by Dr. Halley, and explained by his theory, see WIND, in *Navigation*.

From the same cause it happens, that there are so constant calms in that same part of the ocean, called the *rains*; for this tract being placed in the middle, between the westerly winds blowing on the coast of Guinea, and the easterly trade-winds blowing to the westward of it; the tendency of the air here is indifferent to either, and so stands in equilibrium between both; and the weight of the incumbent atmosphere being diminished by the continual contrary winds blowing from hence, is the reason that the air here holds not the copious vapour it receives, but lets it fall in so frequent rains.

But, as the cold and dense air, by reason of its greater gravity, presses upon the hot and rarefied, it is demonstrable that this latter must ascend in a continued stream as fast as it rarefies; and that, being ascended, it must disperse itself, to preserve the equilibrium; that is, by a contrary current, the upper air must move from those parts where the greatest heat is: so, by a kind of circulation, the north-east trade-wind below will be attended with a south-westerly wind above; and the south-east, with a north-west wind above.

That this is more than a bare conjecture, the almost instantaneous change of the wind to the opposite point, which is frequently found in passing the limits of the trade-winds, seems strongly to assure us; but that which above all confirms this hypothesis, is the phenomenon of the monsoons, by this means most easily solved, and without it hardly explicable. See MONSOONS.

Supposing, therefore, such a circulation as above, it is to be considered, that to the northward of the Indian ocean there is every where land, within the usual limits of the latitude of 30° ; viz. Arabia, Persia, India, &c. which, for the same reason as the Mediterranean parts of Africa, are subject to insufferable heats when the sun is to the north, passing nearly vertical; but yet are temperate enough when the sun is removed towards the other tropic, because of a ridge of mountains at some distance within the land, said to be frequently, in winter, covered with snow, over which the air, as it passes, must needs be much chilled. Hence it happens, that the air coming, according to the general rule, out of the north-east, to the Indian sea, is sometimes hotter, sometimes colder, than that which, by this circulation, is returned out of the south-west; and, by consequence, sometimes the under-current, or wind, is from the north-east, sometimes from the south-west.

That this has no other cause is clear from the times in
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which these winds set, viz. in April; when the sun begins to warm these countries to the north, the south-west monsoons begin, and blow, during the heats, till October, when the sun being retired, and all things growing cooler northward, and the heat increasing to the south, the north-east winds enter, and blow all the winter till April again. And it is, undoubtedly, from the same principle, that to the southward of the equator, in part of the Indian ocean, the north-west winds succeed the south-east, when the sun draws near the tropic of Capricorn. Phil. Transact. N^o 183. or Abridg. vol. ii. p. 139.

Some philosophers, dissatisfied with Dr. Halley's theory above recited, or not thinking it sufficient for explaining the various phenomena of the wind, have had recourse to another cause, viz. the gravitation of the earth and its atmosphere towards the sun and moon, to which the tides are confessedly owing. See TIDES.

From the laws of universal attraction it has been inferred, that these celestial bodies must act upon the atmosphere, or that they must occasion a flux and reflux of the atmosphere, as well as of the ocean. Hence it has been alleged, that though we cannot discover aerial tides, of ebb or flow, by means of the barometer, because columns of air of unequal height, but different density, may have the same pressure or weight; yet the protuberance in the atmosphere, which is continually following the moon, must, they say, of course produce a motion in all parts, and so produce a wind more or less to every place, which, conspiring with or counteracted by the winds arising from other causes, makes them greater or less. Several dissertations to this purpose were published, on occasion of the subject proposed by the Academy of Sciences at Berlin, for the year 1746.

Although the atmospherical air is much more variable than water, and the action of the sun and moon upon it becomes much less apparent to us, because they must frequently concur with or be counteracted by the much more powerful effects of heat and cold, of dryness and moisture, of winds, &c. so that their action upon the barometer has been long disputed and even denied, (see MOON, *Influence of*;) yet that the moon in particular, as well as the sun, has such an action has been for a considerable time furnished; and of late years it has been in a degree observed and rendered sensible by means of very accurate and long-continued barometrical observations, and perceived only by taking a mean of the observations of many years.

Toaldo, the learned astronomer of Padua, after a variety of observations made in the course of several years, found reason to assert, that, *ceteris paribus*, at the time of the moon's apogee, the mercury in the barometer rises the 0.105 of an inch higher than at the perigee; that at the time of the quadratures, the mercury stands 0.008 of an inch higher than at the time of the syzygies; and that it stands 0.022 of an inch higher when the moon in each lunation comes nearest to our zenith, (meaning the zenith of Padua, where the observations were made,) than when it goes farthest from it. Journal des Sciences Utiles.

In the seventh volume of the Philosophical Magazine, there is a paper of L. Howard, esq. which contains several curious observations relative to this subject. This gentleman found, both from his own observations, and from an examination of the Meteorological Journal of the Royal Society, which is published annually in the Philosophical Transactions, that the moon had a manifest action upon the barometer. "It appears," he says, "to me evident, that the atmosphere is subject to a periodical change of gravity, by which the barometer, on a mean of ten years, is depressed at least one-tenth of an inch while the moon is passing from the
3 P quarters

quarters to the full and new; and elevated, in the same proportion, during the return to the quarter." A great fall of the barometer generally takes place before high tides, especially at the time of new or full moon.

The causes, it is said, which render the diurnal tide of the atmosphere insensible to us, may be the elasticity of the air, and the interference of the much more powerful effects of heat, cold, vapours, &c.

It has been calculated by D'Alembert, from the general theory of gravitation, that the influence of the sun and moon in their daily motions is sufficient to produce a continual east wind about the equator. So that, upon the whole, we may reckon three principal daily tides, *viz.* two arising from the attractions of the sun and moon, and the third from the heat of the sun alone: all which sometimes combine together, and form a prodigious tide.

In corroboration of the opinion of the influence of the sun, and principally of the moon, in the production of wind, we must likewise mention the observations of Bacon, Gassendi, Dampier, Halley, &c.; namely, that the periods of the year most likely to have high winds are the two equinoxes; that storms are more frequent at the time of new and full moon, especially those new and full moons which happen about the equinoxes; that, at periods otherwise calm, a small breeze takes place at the time of high water; and that a small movement in the atmosphere is generally perceived a short time after the noon and the midnight of each day.

M. Muschenbroeck, however, will not allow that the attraction of the moon is the cause of the general wind; because the east wind does not follow the motion of the moon about the earth; for in that case there would be more than twenty-four changes, to which it would be subject in the course of a year, instead of two. *Introd. ad Phil. Nat. vol. ii. p. 1102.*

Some action in the production of wind may also be derived from volcanoes, fermentations, evaporations, and especially from the condensation of vapours: for we find that, in rainy weather, a considerable wind frequently precedes the approach of every single cloud, and that the wind subsides as soon as the cloud has passed over our zenith.

Wherever any of the above-mentioned causes are constantly more predominant, as the heat of the sun within the tropics, there a certain direction of the wind is more constant; and where different causes interfere at different and irregular periods, as in those places which are considerably distant from the torrid zone, there the winds are more changeable and uncertain.

In short, whatever disturbs the equilibrium of the atmosphere, *viz.* the equal density or quantity of air at equal distances from the surface of the earth; whatever accumulates the air in one place, and diminishes it in other places, must occasion a wind both in disturbing and in restoring that equilibrium, as above stated.

Mr. Henry Eeles, apprehending that the sun's rarefying of the air cannot simply be the cause of all the regular and irregular motions which we find in the atmosphere, ascribes them to another cause, *viz.* the ascent and descent of vapour and exhalation, attended by the electrical fire or fluid; and on this principle he has endeavoured to explain at large the general phenomena of the weather and barometer. *Phil. Transf. vol. xlix. art. 25. p. 124.*

M. Briffon (*Principes de Physique*) also is of opinion that electricity is the principal and more general cause which produces winds; but Mr. Cavallo is of a different opinion.

After making various observations on the nature and theory of winds, Dr. Darwin recapitulates his opinions in the following manner. 1. The north-east wind consists of

air flowing from the north, where it seems to be occasionally produced; and has an apparent direction from the east, owing to its not having acquired in its journey the increasing velocity of the earth's surface. These winds are analogous to the trade-winds between the tropics, and frequently continue in the vernal months for four or six weeks together, with a high barometer, and fair and frosty weather. They sometimes consist of south-west air, which had passed by us or over us, driven back by a new accumulation of air in the north; and they continue but a day or two, and are attended with rain.

2. The south-west wind consists of air flowing from the south, and seems occasionally absorbed at its arrival to the more northern latitudes. It has a real direction from the west, owing to its not having lost in its journey the greater velocity it had acquired from the earth's surface from whence it came. These winds are analogous to the monsoons between the tropics, and frequently continue for four or six weeks together, with a low barometer, and rainy weather. They sometimes consist of north-east air, which had passed by us, and which becomes retrograde by a commencing deficiency of air in the north. These winds continue but a day or two, attended with severe frost, with a sinking barometer; their cold being increased by their expansion as they return into an incipient vacancy.

3. The north-west wind consists first of south-west winds which have been passed over, been bent down, and driven back towards the south by newly-generated northern air. They continue but a day or two, and are attended with rain or clouds. They consist of north-east winds bent down from the higher parts of the atmosphere, and having there acquired a greater velocity from the earth's surface are frosty and fair. They consist of north-east winds formed into a vertical eddy, not a spiral one, with frost or fair.

4. The north winds consist first of air flowing slowly from the north, so that they acquire the velocity of the earth's surface as they approach it; they are fair or frosty, but seldom occur. They consist of retrograde south winds; these continue but a day or two, are preceded by south-west winds, and are generally succeeded by north-east winds, cloudy or rainy weather, the barometer rising.

5. The south winds consist first of air slowly flowing from the south, losing their previous westerly velocity by the friction of the earth's surface as they approach it; they are moist, but seldom occur. They consist of retrograde north winds; these continue but a day or two, and are preceded by north-east winds, and are generally succeeded by south-west winds, colder, and the barometer sinking.

6. The east winds consist of air brought hastily from the north, and not impelled farther southward, owing to a sudden beginning absorption of air in the northern regions; they are very cold, the barometer high, and are generally succeeded by south-west winds.

7. The west winds consist of air brought hastily from the south, and checked from proceeding farther to the north, by a beginning production of air in the northern regions; they are warm and moist, and generally succeeded by north-east winds. They consist of air bent downwards from the higher regions of the atmosphere; if this air be from the south, and brought hastily, it becomes a wind of great velocity, moving perhaps 60 miles in an hour, and is warm and rainy: if it consists of northern air bent down it is of less velocity, and cooler.

Various other interesting remarks and reflections on winds may be seen in the notes to the Botanic Garden, by the same writer.

WIND.

The industry of some late writers having brought the theory of the production and motion of winds to somewhat of a mathematical demonstration; we shall here give it the reader in that form.

WINDS, Laws of the Production of. If the spring of the air be weakened in any place, more than in the adjoining places; a wind will blow through the place where the diminution is.

For, 1. Since the air endeavours, by its elastic force, to expand itself every way; if that force be less in one place than another, the effort of the more against the less elastic, will be greater than the effort of the latter against the former. The less elastic air, therefore, will resist with less force than it is urged by the more elastic: consequently, the less elastic will be driven out of its place, and the more elastic will succeed.

If, now, the excess of the spring of the more elastic above that of the less elastic air, be such as to occasion a little alteration in the baroscope; the motion both of the air expelled, and that which succeeds it, will become sensible, *i. e.* there will be a wind.

2. Hence, since the spring of the air increases, as the compressing weight increases, and compressed air is denser than air less compressed; all winds blow into rarer air, out of a place filled with a denser.

3. Wherefore, since a denser air is specifically heavier than a rarer; an extraordinary lightness of the air in any place must be attended with extraordinary winds or storms.

Now, an extraordinary fall of the mercury in the barometer, shewing an extraordinary lightness of the atmosphere, it is no wonder if that foretels storms. See **BAROMETER.**

4. If the air be suddenly condensed in any place, its spring will be suddenly diminished: hence, if this diminution be great enough to affect the barometer, there will a wind blow through the condensed air.

5. But since the air cannot be suddenly condensed, unless it have before been much rarefied, there will a wind blow through the air, as it cools, after having been violently heated.

6. In like manner, if air be suddenly rarefied, its spring is suddenly increased: wherefore, it will flow through the contiguous air, not acted on by the rarefying force. A wind, therefore, will blow out of a place, in which the air is suddenly rarefied; and on this principle, in all probability, it is, that,

7. Since the sun's power in rarefying the air is notorious, it must necessarily have a great influence on the generation of winds.

8. Most caves are found to emit wind, either more or less. M. Muschenbroeck has enumerated a variety of causes that produce winds, existing in the bowels of the earth, on its surface, in the atmosphere, and above it. See *Intr. ad Phil. Nat. vol. ii. p. 1116, &c.*

The rising and changing of the wind are determined experimentally, by means of weather-cocks, placed on the tops of houses, &c. But these only indicate what passes about their own height, or near the surface of the earth: Wolfius assures us, from observations of several years, that the higher winds, which drive the clouds, are different from the lower ones, which move the weather-cocks. And Dr. Derham observes something not unlike this. *Phys. Theol. lib. i. cap. 2.*

The author last-mentioned relates, upon comparing several series of observations made of the winds in divers countries; *viz.* England, Ireland, Switzerland, Italy, France, New England, &c. that the winds in those several places seldom agree; but when they do, it is com-

monly when they are strong, and of long continuance in the same quarter; and more, he thinks, in the northerly and easterly than in other points. Also, that a strong wind in one place is oftentimes a weak one in another, or moderate, according as the places are nearer, or more remote. *Phil. Transf. No 267 and 321.*

WIND, Laws of the Force and Velocity of. Wind being only air in motion, and air being a fluid subject to the laws of other fluids, its force may be regularly brought to a precise computation: thus, "The ratio of the specific gravity of any other fluid to that of air, together with the space that fluid, impelled by the pressure of the air, moves in any given time, being given; we can determine the space through which the air itself, acted on by the same force, will move in the same time." By this rule:

1. As the specific gravity of air is to that of any other fluid; so, reciprocally, is the square of the space, which that fluid, impelled by any force, moves in any given time, to the square of the space which the air, by the same impulse, will move in the same time.

Supposing, therefore, the ratio of the specific gravity of

that other fluid to that of air, to be $= \frac{b}{c}$; the space de-

scribed by the fluid to be called s ; and that which the air will describe by the same impulse, x . The rule gives

$$\text{us } x = \sqrt{\frac{b s^2}{c}}$$

Hence, if we suppose water impelled by the given force, to move two feet in a second of time, then will $s = 2$; and since the specific gravity of water to the air is as 800 to 1, we shall have $b = 800$, and $c = 1$; consequently, $x = \sqrt{800 \times 4} = \sqrt{3200} = 57$ feet nearly. The velocity of the wind, therefore, to that of water, moved by the same power, will be as 57 to 2; *i. e.* if water move two feet in a second, the wind will fly 57 feet.

2. Add, that $s = \sqrt{\frac{c x^2}{b}}$; and therefore the space

any fluid, impelled by any impression, moves in any time, is determined, by finding a fourth proportional to the two numbers that express the ratio of the specific gravities of the two fluids, and the square of the space the wind moves in, in the given time. The square root of that fourth proportional is the space required.

Mr. Mariotte, *e. gr.* found, by various experiments, that a pretty strong wind moves 24 feet in a second of time, which is at the rate of 1440 in a minute; *i. e.* at the rate of somewhat more than 16 miles in an hour: wherefore, if the space which the water, acted on by the same force as the air, will describe in the same time, be required; then will $c = 1$, $x = 24$, $b = 800$; and we shall find $s =$

$$\sqrt{\frac{576}{800}} = \frac{24}{\sqrt{800}} \text{ nearly.}$$

Derham estimated the velocity of the wind in very great storms at 66 feet *per* second; and de la Condamine at 90½ feet *per* second.

3. "The velocity of wind being given, to determine the pressure required to produce that velocity;" we have this rule. The space the wind moves in one second of time, is to the height a fluid is to be raised in an empty tube, in order to have a pressure capable of producing that velocity, in a ratio compounded of the specific gravity of the fluid to that of the air, and of quadruple the

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altitude a body descends in the first second of time, to the aforesaid space of the air.

Suppose, *e. gr.* the space through which the air moves in a second, $a = 24$ feet, or 288 inches; call the altitude of the fluid x ; and the ratio of mercury to air,

$$\frac{b}{c} = \frac{800 \times 14}{1} = \frac{11200}{1};$$

and the altitude through which a body descends in the first second of time, 16 feet 1 inch; then, by the theorem, we shall have $288 : x ::$

$$11200 \times 762 : 288, \text{ and consequently } x = \frac{288 \times 288}{11200 \times 762}$$

$= .01$, &c. of an inch. Hence we see why a small but sudden change in the barometer is followed with violent winds. See an account of the principle upon which these calculations are founded under the article WATER.

When the direction of the wind is not perpendicular, but oblique to the surface of the solid, then the force of the former upon the latter will not be so great as when the impulse is direct, and that for reasons which are easily derived from the theory of the resolution and composition of forces, and from the theory of direct and oblique impulses. In short, the general proposition for compound impulses is, that the effective impulse is as the surface, as the square of the air's velocity, as the square of the sine of the angle of incidence, and as the sine of the obliquity of the solid's motion to the direction of the impulse, jointly; for the alteration of every one of those quantities will alter the effect in the same proportion. But these general rules, as we have already more than once observed, are subject to great variations; so that their results seldom coincide with those of actual experiments.

Philosophers have used various methods for determining the velocity of the wind, which is very different at different times. The method used by Dr. Derham was that of letting light downy feathers fly in the wind, and accurately observing the distance to which they were carried in any number of half seconds. This method he preferred to that of Dr. Hooke's *mola alata*, or *pneumatica*. (See Phil. Transf. N^o 24. and Birch's Hist. Roy. Soc. vol. iv. p. 225.) He tells us, that he thus measured the velocity of the wind in the great storm of August, 1705, and by many experiments found, that it moved at the rate of thirty-three feet *per* half-second, or of forty-five miles *per* hour: whence he concludes, that the most vehement wind (as that of November, 1703) does not fly at the rate of above fifty or sixty miles *per* hour, and that at a medium the velocity of wind is at the rate of twelve or fifteen miles *per* hour. Phil. Transf. N^o 313. or Abr. vol. iv. p. 411.

Mr. Brice observes, that experiments with feathers are subject to uncertainty: as they seldom or ever describe a straight line, but describe a sort of spirals, moving to the right and left, and rising to very different altitudes in their progress. He, therefore, considers the motion of a cloud, or its shadow, over the surface of the earth, as a much more accurate measure of the velocity of the wind. In this way he found, that the wind, in a considerable storm, moved at the rate of 62.9 miles *per* hour; and that, when it blew a fresh gale, it moved in the same time about twenty-one miles; and that in a small breeze, the wind moved at the rate of 9.9 miles *per* hour. Phil. Transf. vol. lvi. p. 226.

But it has been observed by Cavallo and others, that this method is very fallacious, partly because it is not known whether the clouds do or do not move exactly with the air in which they float; and partly because the velocity of the air in the region where the clouds float is by no means the

same with that of the air which is nearer to the surface of the earth, and is sometimes quite contrary to it, as indicated by the motion of the clouds themselves. Others have estimated the velocity of the wind by the changes effected by it upon the motion of sound, which must of course be very inaccurate. A very simple method of determining the velocity of the wind is that which M. Coulomb (Mem. de l'Acad. Roy. 1781, p. 70.) employed in his experiments on wind-mills, because it requires neither the aid of instruments nor the trouble of calculation. Two persons were placed on a small elevation, at the distance of 150 feet from one another, in the direction of the wind; and, while the one observed, the other measured the time which a small and light feather employed in removing through this space. The distance between the two persons, divided by the number of seconds, gave the velocity of the wind *per* second. The best method, says Cavallo, of measuring the velocity of the wind, is by observing the velocity of the smoke of a low chimney, or by estimating the effect it produces upon certain bodies, and thus may be determined its force as well as its velocity. We shall here observe, that from the concurrence of experiments made with various instruments, and different modes of calculation, it has been inferred, that in currents of air, of the denomination which are expressed in the 4th column of the annexed table, the air moves at the rate of so many feet *per* second as are expressed in the 2d column, or of so many miles *per* hour as are expressed in the 1st column.

A TABLE of the different velocities and forces of the winds, constructed by Mr. Rouse with great care, from a considerable number of facts and experiments, and communicated to Mr. Smeaton, and first published by him in the 51st volume of the Philosophical Transactions.

Velocity of the Wind.		Perpendicular Force on one square Foot, in Avoirdupois Pounds.	Common Appellations of the Forces of Winds.
Miles in one Hour.	= Feet in one Second.		
1	1.47	.005	Hardly perceptible.
2	2.93	.020	
3	4.40	.044	Just perceptible.
4	5.87	.079	
5	7.33	.123	Gentle pleasant wind.
10	14.67	.492	
15	22.00	1.107	Pleasant brisk gale.
20	29.34	1.968	
25	36.67	3.075	Very brisk.
30	44.01	4.429	
35	51.34	6.027	High wind.
40	58.68	7.873	
45	66.01	9.963	Very high.
50	75.35	12.300	
60	88.02	17.715	A storm or tempest.
80	117.36	31.490	A great storm.
			A hurricane.
100	146.70	49.200	{ A hurricane that tears up trees, and carries buildings, &c. before it.

The force of the wind is as the square of its velocity; as Mr. Ferguson has shewn by experiments on the whirling-table; and in moderate velocities this will hold very nearly. Upon

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Upon this principle the numbers in the third column are calculated. The proposition upon which this column has been formed seems to be, that the impulse of a current of air, striking perpendicularly upon a given surface, with a certain velocity, is equal to the weight of a column of air which has that surface for its base, and for its height the space through which a body must fall, in order to acquire that velocity of the air.

It is observed, with regard to this table, that the evidence for those numbers, where the velocity of the wind exceeds fifty miles an hour, does not seem of equal authority with that of those of fifty miles, or under. Phil. Trans. vol. li. p. 165.

Dr. Hales found (Statical Ess. vol. ii. p. 326.) that the air rushed out of a pair of smith's bellows, at the rate of 68.73 feet in a second of time, when compressed with a force equal to the weight of one inch perpendicular depth of mercury, lying on the whole upper surface of the bellows. The velocity of the air, as it passed out of the trunk of his ventilators, was found to be at the rate of three thousand feet in a minute; which is at the rate of thirty-four miles in an hour. Dr. Hales says, that the velocity with which impelled air passes out at any orifice may be determined by hanging a light valve over the nose of a bellows, by pliant leathern hinges, which will be much agitated and lifted up from a perpendicular to a more than horizontal position by the force of the rushing air. There is another more accurate way, he says, of estimating the velocity of air, viz. by holding the orifice of an inverted glass siphon full of water, opposite to the stream of air, by which the water will be depressed in one leg, and raised in the other, in proportion to the force with which the water is impelled by the air. Descript. of Ventilators, 1743, p. 12, &c.

The velocity and force of the wind are determined experimentally by a peculiar machine, called an *anemometer* or *wind-measurer*. Of these there have been many, variously constructed. See ANEMOMETER, ANEMOSCOPE, and WIND-GAGE.

WIND, *Qualities and Effects of*. 1. "A wind blowing from the sea is always moist; in summer, it is cold; and in winter, warm, unless the sea be frozen up." This is demonstrated thus: there is a vapour continually rising out of all water, (as appears even hence, that a quantity of water, being left a little while in an open vessel, is found sensibly diminished,) but especially if it be exposed to the sun's rays; in which case, the evaporation is beyond all expectation. By this means, the air incumbent on the sea becomes impregnated with a quantity of vapour. But the winds, blowing from off the sea, sweep these vapours along with them; and consequently they are always moist.

Again, water in summer, &c. conceives less heat than terrestrial bodies, exposed to the same rays of the sun, do; but in winter, sea-water is warmer than the earth covered with frost and snow, &c. Wherefore, as the air contiguous to any body is found to partake of its heat and cold, the air contiguous to sea-water will be warmer in winter, and colder in summer, than that contiguous to the earth. Or thus: vapours raised from water by the sun's warmth in winter, are warmer than the air they rise in, (as appears from the vapours condensing, and becoming visible, almost as soon as they are got out into air.) Fresh quantities of vapour, therefore, continually warming the atmosphere over the sea, will raise its heat beyond that of air over the land. Again, the sun's rays reflected from the earth into the air, in summer, are much more than those from the water into air: the air, therefore, over the earth, warmed by the re-

fection of more rays than that over water, is warmer. Hence, *sea-winds* make thick, cloudy, hazy weather.

2. "Winds, blowing from the continent, are always dry; in summer, warm; and cold in winter." For there is much less vapour arising from the earth, than from water; and, therefore, the air over the continent will be impregnated with much fewer vapours. Add, that the vapours, or exhalations, raised by a great degree of heat out of the earth, are much finer, and less sensible, than those from water. The wind, therefore, blowing over the continent, carries but little vapour with it, and is therefore dry.

Farther, the earth in summer is warmer than water exposed to the same rays of the sun. Hence, as the air partakes of the heat of contiguous bodies, that over the earth in summer will be warmer than that over the water: therefore, the winds, &c.

After the like manner it is shewn, that the land-winds are cold in winter. Hence, we see why land-winds make clear cold weather.

Our northerly and southerly winds, however, which are commonly esteemed the causes of cold and warm weather, Dr. Derham observes, are really rather the effect of the cold or warmth of the atmosphere. Hence it is, that we frequently see a warm southerly wind, on a sudden, changed to the north, by the fall of snow or hail; and that in a cold frosty morning, we see the wind north, which afterwards wheels about toward the southerly quarter, when the sun has well warmed the air; and again, in the cold evening, turns northerly, or easterly. See Darwin's Observations *supra*.

For the manner in which north-easterly winds contribute to blights, see BLIGHT. For the effect of winds on the barometer and thermometer, see BAROMETER, &c.

The utility of winds has been universally acknowledged. The ancient Persians, Phœnicians, Greeks, and Romans, sacrificed and erected temples to the winds; as we learn from Vossius, Theolog. Gentil. lib. iii. part i. cap. i. Besides their use in moving bellows, mills, and other machines, applied in various ways to the service of mankind, and the benefits resulting from them to navigation and trade, they serve to purify and refresh the air, to convey the heat or cold of one region to another, to produce a regular circulation of vapours from the ocean to countries remote from it, and to supply, by wafting them in their progress against hills, &c. springs and rivers.

Wind has been, by many authors, made the basis of many different diseases: among others, Dr. Reyn has given it as his opinion, in a Treatise on the Gout (De Arthritid.), that flatules, or wind inclosed between the periosteum and the bone, are the true cause of that disease; and accordingly, that all the methods of cure ought to tend to the expelling of that wind.

He is also of opinion, that head-aches, palpitations of the heart, tooth-ache, pleurisy, convulsions, colics, and many other diseases, are originally owing to the same cause, and only differ in regard to the place affected, and to the various motions and determinations of the wind. The moveableness of the pain in gouty persons from one part to another, he looks on as a proof of this, and thinks that the curing of the gout by burning moxa, or the cotton of the mugwort leaves, upon it, is owing to its giving way to the wind in the part to evaporate itself.

That these winds are cold, appears from the shivering fits which generally precede a paroxysm of the gout; and that the shiverings in the beginning of fevers, and before all fits of agues, are owing to the same cause, is supposed by
this

this author a natural conclusion from the former observations.

Their differences, he says, principally proceed from the various ferments producing in us a variety of humours; which acting upon one another, do in their effervescences create winds of various effects, and denominate diseases from the places which are the scenes of their action. It is on this account that the *acupunctura*, or pricking with long needles, among the Chinese, is of use: the Japanese, and other neighbouring nations, having no other cure for most diseases than the pricking with the needle, and the burning of the moxa on the part.

The husbandman often suffers extremely by high winds in many different respects. Plantations of trees, at a small distance from the barns and houses, are the best safeguard against their suffering by winds; but they must not be planted so near as that their fall, if it should happen, would endanger them. Yews grow very slowly, otherwise they are the best of all trees for this defensive plantation. Trees suffer by winds, being either broken or blown down by them: but this may be in a great measure prevented by cutting off great part of the heads and branches of them, in places where they stand most exposed.

Hops are the most subject to be injured by winds of any crop; but this may be in a great measure prevented by a high pale, or very thick thorn-hedge; this will both keep off the spring wind, which nips the young buds, and be a great safeguard against other winds that would tear the plants from their poles. The poles should always be very firm in the ground; and the best security to be added to this, is a row of tall trees all round the ground.

Winds, attended with rain, do great injury to the corn, by laying it flat to the ground. The best method of preventing this, is to keep up good enclosures; and if the accident happens, the corn should be cut immediately, for it never grows at all afterwards. It should be left on the ground, in this case, some time after the cutting, to harden the grain in the ear. Mortimer's Husbandry, p. 302.

WIND, in *Navigation*, is the same agitation of the air, considered as serving for the motion of vessels on the water.

If the wind blows gently, it is called a *breeze*; if it blows harder, it is called a *gale*, or a stiff gale; and if it blows very hard, it is called a *storm*.

The following observations on the wind have been made by skilful seamen, and particularly by Dr. Halley.

1. Between the limits of 60° , *viz.* from 30° of north latitude to 30° of south latitude, there is a constant, or almost constant, east wind through the year, blowing in the Atlantic and Pacific oceans, called the *trade-wind*; which see.

2. The trade-winds, near their northern limits, blow between the north and east; and near their southern limits they blow between the south and east.

The trade-wind seems to depend principally upon the rarefaction of the air, which is occasioned by the heat of the sun progressively from the east towards the west. The air which is rarefied, and, of course, elevated by the heat of the sun immediately over it, is condensed, and descends as soon as the sun is gone over another place to the west of the former; then the air of the latter place is rarefied, and the condensed air of the former rushes towards it, &c. From the northern and southern parts of the world, the air likewise runs to the place which is immediately under the sun; but those directions, combining with the easterly wind, which blows nearer to the equator, form the above-mentioned

north-easterly and south-easterly winds on the borders of the trade-wind.

3. These general motions of the wind are disturbed on the continents, and near their coasts.

In places that are farther from the equator, the rarefaction which arises from the heat of the sun, and from the attraction of the sun and moon, is less active; and is besides influenced by a variety of local and accidental circumstances, such as extensive continents, mountains, rains, islands, &c. which disturb, interrupt, or totally change the direction of the wind. Hence, in those latitudes north and south, which are beyond the limits of the trade-wind, or near the coasts, the winds are very uncertain; nor has any good theory been as yet formed respecting them.

4. In some parts of the Indian ocean there are periodical winds, which are called *Monsoons*; which see.

For the explication of these, it is said, that as the air, which is cool and dense, will force the warm rarefied air in a continual stream upwards, there it must spread itself to preserve the equilibrium. Therefore the upper course or current of air must be contrary to the under current; for the upper air must move from those parts where the greatest heat is; and so, by a kind of circulation, the N.E. trade-wind below will be attended with a S.W. above; and a S.E. below, with a N.W. above.

5. In the Atlantic ocean, near the coasts of Africa, at about a hundred leagues from the shore, between the latitudes of 28° and 10° north, seamen constantly meet with a fresh gale of wind blowing from the N.E.

6. Those bound to the Caribbee islands, across the Atlantic ocean, find, as they approach the American side, that the said N.E. wind becomes easterly; or seldom blows more than a point from the east, either to the northward or southward. These trade-winds, on the American side, are extended to 30° , 31° , or even to 32° of N. latitude; which is about 4° farther than they extend on the African side: also to the southward of the equator, the trade-winds extend three or four degrees farther toward the coast of Brasil, on the American side, than they do near the Cape of Good Hope, on the African side.

7. Between the latitudes of 4° N. and 4° S., the wind always blows between the south and east: on the African side, the winds are nearest the south; and on the American side, nearest the east. In these seas, Dr. Halley observed, that when the wind was eastward, the weather was gloomy, dark, and rainy, with hard gales of wind; but when the wind veered to the southward, the weather generally became serene, with gentle breezes, approaching to a calm. These winds are somewhat changed by the seasons of the year; for when the sun is far northward, the Brasil S.E. wind turns to the south, and the N.E. wind to the east; and when the sun is far south, the S.E. wind gets to the east, and the N.E. winds on this side of the equator veer more to the north.

8. Along the coast of Guinea, from Sierra Leone to the island of St. Thomas, under the equator, which is above five hundred leagues, the southerly and south-west winds blow perpetually; for the S.E. trade-wind, having passed the equator, and approaching the Guinea coast within eighty or a hundred leagues, inclines toward the shore, and becomes south, then S.E., and by degrees, as it comes near the land, it veers about to south, S.S.W., and in with the land it is S.W. and sometimes W.S.W. This tract is subject to frequent calms, violent sudden gusts of winds, called tornadoes, blowing from all points of the horizon.

The westerly wind on the coast of Guinea is probably owing

owing to the nature and situation of the land, which, being greatly heated by the sun, rarefies the air exceedingly; hence the cooler and heavier air from over the sea will keep rushing in to restore the equilibrium.

9. Between the fourth and tenth degrees of north latitude, and between the longitudes of Cape Verd, and the easternmost of the Cape Verd isles, there is a tract of sea subject to perpetual calms, attended with frequent thunder and lightning, and rains; whence this part of the sea is called 'The Rains.' Ships in sailing these six degrees are said to have been sometimes detained whole months.

The cause of this seems to be, that the westerly winds setting in on this coast, and meeting the general easterly wind in this tract, balance each other, and cause the calms; and the vapour carried thither by the hottest wind, meeting the coolest, is condensed, and occasions the very frequent rains.

The three last observations account for two circumstances which mariners experience in sailing from Europe to India, and in the Guinea trade.

The *first* is the difficulty which ships, in going to the southward, especially in the months of July and August, find in passing between the coast of Guinea and Brasil, although the breadth of this sea is more than five hundred leagues. This happens, because the S.E. winds at that time of the year commonly extend some degrees beyond the ordinary limits of four degrees north latitude; and besides coming so much southerly, as to be sometimes south, sometimes a point or two to the west; it then only remains to ply to windward: and if, on the one side, they steer W.S.W. they get a wind more and more easterly; but then there is a danger of falling in with the Brasilian coast, or shoals; and if they steer E.S.E. they fall into the neighbourhood of the coast of Guinea, from whence they cannot depart without running easterly as far as the island of St. Thomas; and this is the constant practice of all the Guinea ships.

Secondly, With regard to all ships departing from Guinea for Europe, their direct course is northward; but on this course they cannot go, because the coast bending nearly east and west the land is to the northward: therefore, as the winds on this coast are generally between the S. and W.S.W., they are obliged to steer S.S.E. or S., and with these courses they run off the shore; but in so doing they always find the winds more and more contrary; so that when near the shore they can lie south, at a greater distance they can make no better than S.E., and afterwards E.S.E.; with which courses they commonly fetch the island of St. Thomas and Cape Lopez, where, finding the winds to the eastward of the south, they sail westerly with it, till coming to the latitude of four degrees south, they there find the S.E. winds blowing perpetually.

On account of these general winds, all those that use the West India trade, even those bound to Virginia, reckon it their best course to get as soon as they can to the southward, that so they may be certain of a fair and fresh gale to run before it to the westward; and for the same reason, those homeward-bound from America endeavour to gain the latitude of thirty degrees, where they first find the winds begin to be variable; though the most ordinary winds in the North Atlantic ocean come from between the south and west.

10. Between the southern latitudes of ten and thirty degrees in the Indian ocean, the general trade-wind about the S.E. by S. is found to blow all the year long in the same manner as in the like latitude in the Ethiopic ocean; and during the six months from May to December, these winds reach to within two degrees of the equator; but

during the other six months, from November to June, a N.W. wind blows in the tract lying between the third and tenth degrees of southern latitude, in the meridian of the north end of Madagascar; and between the second and twelfth degree of south latitude, near the longitude of Sumatra and Java.

11. In the tract between Sumatra and the African coast, and from three degrees of south latitude quite northward to the Asiatic coasts, including the Arabian sea and the gulf of Bengal, the monsoons blow from September to April on the N.E., and from March to October on the S.W. In the former half year the wind is more steady and gentle, and the weather clearer than in the latter six months; and the wind is more strong and steady in the Arabian sea than in the gulf of Bengal.

12. Between the island of Madagascar and the coast of Africa, and thence northward as far as the equator, there is a tract, in which, from April to October, there is a constant fresh S.S.W. wind; which to the northward changes into the W.S.W. wind, blowing at that time in the Arabian sea.

13. To the eastward of Sumatra and Malacca on the north of the equator, and along the coasts of Cambodia and China, quite through the Philippines as far as Japan, the monsoons blow northerly and southerly; the northern setting in about October or November, and the southern about May: these winds are not quite so certain as those in the Arabian seas.

14. Between Sumatra and Java to the west, and New Guinea to the east, the same northerly and southerly winds are observed; but the first half-year monsoon inclines to the N.W., and the latter to the S.E. These winds begin a month or six weeks after those in the Chinese seas set in, and are quite as variable.

15. These contrary winds do not shift from one point to its opposite all at once: in some places, the time of the change is attended with calms; in others, by variable winds; and it often happens on the shores of Coromandel and China, towards the end of the monsoons, that there are most violent storms, greatly resembling the hurricanes in the West Indies; in which the wind is so very strong, that hardly any thing can resist its force.

All navigation in the Indian ocean must necessarily be regulated by these winds; for if mariners should delay their voyages till the contrary monsoon begins, they must either sail back, or go into harbour, and wait for the return of the trade-wind.

16. The irregularities of the wind in countries which are farther from the equator than those which have been mentioned above, or nearer to the poles of the earth, are so great that no particular period has as yet been discovered, excepting that in particular places certain winds are more likely to blow than others. Thus at Liverpool the winds are said to be westerly for near two-thirds of the year; in the southern part of Italy, a south-east wind (called the *schirocco*) blows more frequently than any other wind, &c.

17. The temperature of a country with respect to heat or cold is increased or diminished by winds, according as they come from a hotter or colder part of the world. The north and north-easterly winds, in this country and all the western parts of Europe, are reckoned cold and drying winds. They are cold, because they come from the frozen region of the north pole, or over a great tract of cold land. Their drying quality is derived from their coming principally over land, and from a well-known property of the air; namely, that warm air can dissolve, and keep dissolved, a

greater quantity of water than colder air: hence the air which comes from colder regions, being heated over warmer countries, becomes a better solvent of moisture, and dries up with greater energy the moist bodies it comes in contact with; and, on the other hand, warm air coming into a colder region deposits a quantity of the water it kept in solution, and occasions mists, fogs, clouds, rains, &c. "In short," says colonel Roy, "the winds seem to be drier, denser, and colder, in proportion to the extent of land they pass over from the poles towards the equator; but they appear to be more moist, warm, and light, in proportion to the extent of ocean they pass over from the equator towards the poles. Hence the humidity, warmth, and lightness, of the Atlantic winds to the inhabitants of Europe. On the east coasts of North America the severity of the N.W. wind is universally remarked; and there can scarcely be a doubt, that the inhabitants of California, and other parts on the west side of that great continent, will, like those on the west of Europe, feel the strong effects of a N.E. wind."

18. In warm countries, sometimes the winds, which blow over a great tract of highly-heated land, become so very drying, scorching, and suffocating, as to produce dreadful effects. These winds, under the names of *Blooms*, *Samiel*, and *Solanos*, are often felt in the deserts of Arabia, in the neighbourhood of the Persian gulf, in the interior of Africa, and in some other places. There are likewise in India, part of China, part of Africa, and elsewhere, other winds, which deposit so much warm moisture as to soften, and actually to dissolve glue, salts, and almost every article which is soluble in water.

19. It is impossible to give any adequate account of irregular winds, especially of those sudden and violent gusts as come on at very irregular periods, and generally continue for a short time. They sometimes spread over an extensive tract of country, and at other times are confined within a remarkably narrow space. Their causes are by no means rightly understood, though they have been vaguely attributed to peculiar rarefactions, to the combined attractions of the sun and moon, to earthquakes, to electricity, &c. They are called in general *hurricanes*, or they are the principal phenomenon of a hurricane, that is, of a violent storm.

Almost every one of those violent winds is attended with particular phenomena, such as droughts, or heavy rains, or hail, or snow, or thunder and lightning, or several of those phenomena at once. They frequently shift suddenly from one quarter of the horizon to another, and then come again to the former point. In this case they are called *tornadoes*.

In mountainous countries, the wind sometimes rages with extreme violence, and the mountains generally exhibit signs of the approaching storm. Thus, at the Cape of Good Hope, there are four remarkable mountains, called *Table Land*, or *Mountain*; *Sugar-Loaf*, or the *Lion's Head*; *James Mount*, or the *Lion's Rump*; and *Charles Mount*, called also the *Devil's Tower*, or *Devil's Head*, from the violent squalls of wind which come from it. In the summer season *Table Mountain* is sometimes suddenly covered with a white cloud, called the *Table-cloth*; when this cloud seems to roll down the steep face of the mountain, it is a sure indication of an approaching gale of wind from the S.E., which generally blows with great violence, and sometimes continues a day or more, but in common is of short duration. On the first appearance of this cloud, the ships in *Table bay* begin to prepare for it, by striking yards and top-masts, and making every thing as snug as possible. If, in the morning, the cloud extends from the *Table* to *Mount Charles*, or the *Devil's Tower*, which are almost contiguous,

it is a general saying among seamen, that the old gentleman is going to breakfast; if in the middle of the day, that he is going to dinner; and if in the evening, that the cloth is spread for supper.

There are various other periodical winds: of these, however, that generally known by the name of *Limat*, which is common in the island of Cyprus, shall only be mentioned here. The period of this wind is five days: on the first day, it begins to blow at eight in the morning, and increases till noon; from thence it gradually weakens, and ceases entirely about three P.M. On the second day, it arises at the same hour; but it does not attain its greatest strength till about one in the afternoon, and ceases at four. On the third day, it begins as before; but it falls an hour later. On the remaining days, it follows the same progression as on the third; but it is remarked, that a little before it ceases, it becomes extremely violent. Upon the N.W. side of the above island, this wind is considered as a sea-breeze; and upon the S.E. as a land-breeze. See *WIND, Qualities of, supra*. See also *HURRICANES, TORNADOES, and WHIRL-Wind*. See *Phil. Trans. N° 183, or Abr. vol. ii. p. 133, &c.* Robertson's *Elem. of Nav. b. vi. f. 6.* Cavallo's *Philos. vol. ii.*

The winds are divided, with respect to the points of the horizon from which they blow, into *cardinal* and *collateral*.

WINDS, Cardinal, are those blowing from the four cardinal points; east, west, north, and south.

Thus, a wind that blows from the E. towards the W. is called *east wind*; when it blows from the W. towards the E., *west wind*; when it blows from the N. to the S., it is called *north wind*; and when it blows from the S. towards the N., it is called *south wind*.

WINDS, Collateral, are the intermediate winds between any two cardinal winds. The number of these is infinite, as the points from which they blow are; but only a few of them are considered in practice; *i. e.* only a few of them have their distinguishing names.

Those winds which deviate a little from the cardinal points are called *northerly, easterly, southerly, and westerly* winds. But for the sake of greater distinction, the space or arch which lies between any two contiguous cardinal points, is supposed, by the mariners, to be divided into eight equal parts, or *points*, and each point into four equal parts, called *quarter-points*. So that the horizon is supposed to be divided into thirty-two principal points, which are called *rhumbs*, or *winds*, to each of which a particular name is assigned; and those names are derived from the names of the adjacent cardinal points. See *COMPASS*.

The ancient Greeks, at first, only used the four cardinal ones; at length they took in four more. Vitruvius gives us a table of twenty, besides the cardinals, which were in use among the Romans.

The moderns, as their navigation is much more perfect than that of the ancients, have given names to twenty-eight collateral winds, which they range into *primary* and *secondary*; and the secondary they subdivide into those of the *first* and *second order*.

The English names of the primary collateral winds and points are compounded of the names of the cardinal ones, north and south being still prefixed.

The names of the secondary collateral winds of the first order are compounded of the names of the cardinals, and the adjacent primary one. Those of the second order are compounded of the names of the cardinal, or the next adjacent primary; and the next cardinal, with the addition of the word *by*. The Latins have distinct names for each; all which are expressed in the following Table.

WIND.

Names of the Winds and Points of the Compass.		Distances of the Points, &c. from the North.
English.	Latin and Greek.	
1. North.	<i>Septentrio, or Boreas.</i>	0° 0'
2. North by east.	{ <i>Hyperboreas.</i> <i>Hypaquilo.</i> <i>Gallicus.</i> }	11 15
3. North-north-east.	<i>Aquilo.</i>	22 30
4. North-east by north.	{ <i>Mefoboreas.</i> <i>Mefaquilo.</i> <i>Supernas.</i> }	33 45
5. North-east.	{ <i>Aræapeliotes.</i> <i>Borapeliotes.</i> <i>Græcus.</i> }	45
6. North-east by east.	<i>Hypocæfias.</i>	56 15
7. East-north-east.	<i>Cæfias, Hellefpontius.</i>	67 30
8. East by north.	{ <i>Mefocæfias.</i> <i>Carbas.</i> }	78 45
		From the E.
9. East.	{ <i>Solanus, subfolanus,</i> <i>apeliotes.</i> }	0° 0'
10. East by south.	{ <i>Hypeurus, or hy-</i> <i>pereurus.</i> }	11 15
11. East-south-east.	<i>Eurus, or voltarnus.</i>	22 30
12. South-east by east.	<i>Mefeurus.</i>	33 45
13. South-east.	<i>Notapeliotes, curaster.</i>	45
14. South-east by south.	<i>Hypophænix.</i>	56 15
15. South-south-east.	{ <i>Phænix, phœnicias,</i> <i>leuco-notus, gan-</i> <i>geticus.</i> }	67 30
16. South by east.	<i>Mefophænix.</i>	78 45
		From the S.
17. South.	<i>Aufter, notus, meridiæ.</i>	0° 0'
18. South by west.	{ <i>Hypolibonotus, al-</i> <i>fanus.</i> }	11 15
19. South-south-west.	{ <i>Libonotus, notoliby-</i> <i>cus, auftro-africus.</i> }	22 30
20. South-west by south.	<i>Mefolibonotus.</i>	33 45
21. South-west.	{ <i>Noto-zephyrus.</i> <i>Noto-libycus.</i> <i>Africus.</i> }	45
22. South-west by west.	{ <i>Hypolibs.</i> <i>Hypafricus.</i> <i>Subvefperus.</i> }	56 15
23. West-south-west.	<i>Libs.</i>	67 30
24. West by south.	{ <i>Mefolibs.</i> <i>Mefozephyrus.</i> }	78 45

Names of the Winds and Points of the Compass.		Distances of the Points, &c. from the West.
English.	Latin and Greek.	
25. West.	{ <i>Zephyrus, favonius,</i> <i>occidens.</i> }	0° 0'
26. West by north.	{ <i>Hypargeftes.</i> <i>Hypocorus.</i> }	11 15
27. West-north-west.	{ <i>Argeftes.</i> <i>Caurus, corus,</i> <i>iapyx.</i> }	22 30
28. North-west by west.	{ <i>Mefargeftes.</i> <i>Mefocorus.</i> }	33 45
29. North-west.	{ <i>Zephyro-boreas, boro-</i> <i>libycus, olympias.</i> }	45
30. North-west by north.	{ <i>Hypocircius.</i> <i>Hypothrafcias.</i> <i>Scirem.</i> }	56 15
31. North-north-west.	<i>Circius, thrafcias.</i>	67 30
32. North by west.	<i>Mefocircius.</i>	78 45

Note.—The ancient names are here, after Ricciolus, adapted to the modern ones; not that the winds formerly denoted by those were precisely the same with these, (for the ancient number and division being different from the modern, the points they refer to will necessarily be somewhat different,) but these are what come the nearest. Thus, Vitruvius, only reckoning twenty-four winds, difposes the points they refer to in a different order; as in the following Table.

Names of the Winds.	Distance from North.	Names of the Winds.	Distance from East.
1. <i>Septentrio.</i>	0°	7. <i>Solanus.</i>	0°
2. <i>Gallicus.</i>	15	8. <i>Ornithias.</i>	15
3. <i>Supernas.</i>	30	9. <i>Cæfias.</i>	30
4. <i>Aquilo.</i>	45	10. <i>Eurus.</i>	45
5. <i>Boreas.</i>	60	11. <i>Voltarnus.</i>	60
6. <i>Carbas.</i>	75	12. <i>Euronotus.</i>	75
Names of the Winds.	Distance from South.	Names of the Winds.	Distance from West.
13. <i>Aufter.</i>	0°	19. <i>Favonius.</i>	0°
14. <i>Alfanus.</i>	15	20. <i>Etefæ.</i>	15
15. <i>Libonotus.</i>	30	21. <i>Circius.</i>	30
16. <i>Africus.</i>	45	22. <i>Caurus.</i>	45
17. <i>Subvefper.</i>	60	23. <i>Corus.</i>	60
18. <i>Argeftes.</i>	75	24. <i>Thrafcias.</i>	75

WIND.

The following Table shews the angles which every rhumb or point of the compass makes with the meridian: by means of which the direction of the wind, &c. may be determined.

NORTH.	SOUTH.	Points.	D.	M.	NORTH.	SOUTH.
		$\frac{1}{4}$	2	49		
		$\frac{1}{2}$	5	$37\frac{1}{2}$		
		$\frac{3}{4}$	8	26		
N. by E.	S. by E.	1	11	15	N. by W.	S. by W.
		$1\frac{1}{4}$	14	4		
		$1\frac{1}{2}$	16	$52\frac{1}{2}$		
		$1\frac{3}{4}$	19	41		
N.N.E.	S.S.E.	2	22	30	N.N.W.	S.S.W.
		$2\frac{1}{4}$	25	19		
		$2\frac{1}{2}$	28	$7\frac{1}{2}$		
		$2\frac{3}{4}$	30	56		
N.E. by N.	S.E. by S.	3	33	45	N.W. by N.	S.W. by S.
		$3\frac{1}{4}$	36	34		
		$3\frac{1}{2}$	39	$22\frac{1}{2}$		
		$3\frac{3}{4}$	42	11		
N.E.	S.E.	4	45	0	N.W.	S.W.
		$4\frac{1}{4}$	47	49		
		$4\frac{1}{2}$	50	$37\frac{1}{2}$		
		$4\frac{3}{4}$	53	26		
N.E. by E.	S.E. by E.	5	56	15	N.W. by W.	S.W. by W.
		$5\frac{1}{4}$	59	4		
		$5\frac{1}{2}$	61	$52\frac{1}{2}$		
		$5\frac{3}{4}$	64	41		
E.N.E.	E.S.E.	6	67	30	W.N.W.	W.S.W.
		$6\frac{1}{4}$	70	19		
		$6\frac{1}{2}$	73	$7\frac{1}{2}$		
		$6\frac{3}{4}$	75	56		
E. by N.	E. by S.	7	78	45	W. by N.	W. by S.
		$7\frac{1}{4}$	81	34		
		$7\frac{1}{2}$	84	$22\frac{1}{2}$		
		$7\frac{3}{4}$	87	11		
EAST.	EAST.	8	90	0	WEST.	WEST.

For the use of the winds in navigation, &c. see SAILING.
WIND, a disease in sheep of a very dangerous and distressing kind.

It is observed in the Shepherd's Guide, that in this complaint, the sheep, immediately after being clipped or shorn, appear to be in violent pain, their sides are somewhat extended, and their breathing very short, the head is hung down drooping, and they have a great aversion to moving or walking. These symptoms continue to increase until the sheep dies, which is in a very few hours, unless a violent purging comes on, which generally gives immediate relief. On inquiring for the name of this affection, the writer says, he found it was called the wind, but where the seat of it lay few could tell him; some thought it was in the head, others in the lungs; and the remedies they applied were as various as their opinions of the nature of the disease.

Not being satisfied with these accounts, he endeavoured, by inspecting the carcases of sheep that died of the disease, to discover the cause and seat of the complaint. On opening four sheep that died of the disease, he found all

the intestines rather distended with flatus, but not in any great degree. Their blood-vessels were very turgid, and of a deep red, particularly those of the large intestines, excepting the rectum, or what is called the *bum-gut*, which had a healthy appearance, as likewise had the stomach, milt, caul, liver, heart, lungs, and in short all the viscera contained in the cavity of the trunk. From these appearances he will venture to say, that the disease in question is a violent inflammation of the intestines, perhaps in some measure arising from bruises in shearing, but more so from losing a warm clothing, and being suddenly exposed to cold air and cold feeding.

He therefore recommends to farmers, that on the first appearances of the complaint they put the sheep into a stable or other warm place, and immediately bleed it freely. Then to bruise a quarter of an ounce of some carminative seed, such as carraway, anise, cummin, or fennel, and to mix these with two ounces of Glauber's purging salts, in a pint of water, placing it on a fire, and making it boil for a few minutes, then to strain it off. Then to add a quarter of an ounce

ounce of powdered jalap, and while lukewarm to give the sheep a quarter of a pint of this liquor, well shaken together, every half hour till it dungs. It should have no food or cold water until recovered, but a little warm water might be of service in some cases.

This is a disorder which is in general so suddenly fatal, that recourse should be instantly had to any remedy that may have been found beneficial; but bleeding is probably that on which the greatest dependence may be placed, with calomel in some instances.

WIND, among *Animals*, is another name for the breath, or rather for the power with which the lungs are endowed in the exercise of their functions, which in many cases is a sort of morbid affection of them, especially in horses, swine, calves, and some others. Horses are often thick-winded and purfise, which is this state, and require much exercise and management, and the other two are sometimes affected in much the same way.

WIND, in *Rural Economy*, a term applied to a winch or wince in some places.

WIND, *Fresh*. See FRESH.

WIND, *To haul the*. See HAUL.

WIND, *Large*, in the *Sea Language*. See LARGE.

WIND, *Quarter*, at *Sea*. See QUARTER.

WINDS, *Reigning*. See REIGNING.

WINDS, *Tropic*. See TRADE-WINDS, and WIND *supra*.

WIND, *Side*, at *Sea*, that which blows on the side of the ship.

To WIND a Ship or Boat, in *Sea Language*, is to change her position, by bringing the stern to lie in the situation of the head, or directly opposite to its former situation.

WIND, in the *Manege*. A horse that carries in the wind, is one that tosses his nose as high as his ears, and does not carry handsomely.

The difference between carrying in the wind and beating upon the hand is, that a horse who beats upon the hand shakes his head, and resists the bridle; but he who carries in the wind, puts up his head without shaking, and only sometimes beats upon the hand. The opposite to carrying in the wind is arming and carrying low.

WIND, *Whirl*. See WHIRL-WIND.

WIND, *Colic*. See COLIC.

WIND-*Dropsy*. See TYMPANITES.

WIND-*Egg*, an addle egg, or an egg that has taken wind. See EGG.

WIND-*Fall* denotes fruit blown off the tree by the wind.

WIND-*Flower*, in *Botany*. See ANEMONE.

WIND-*Furnace*. See FURNACE.

WIND-*Gage*, in *Pneumatics*, an instrument serving to determine the velocity and force of the wind. See ANEMOMETER, ANEMOSCOPE, and *Laws of the Force, &c. of the Wind supra*.

Dr. Lind, of Edinburgh, has contrived an apparatus of this kind, which is simple and easy of construction, and which seems to be well adapted for measuring the force of the wind with a sufficient degree of accuracy. This instrument consists of two glass tubes A B, C D, (*Plate XV. Pneumatics, fig. 9.*) five or six inches in length, and about four-tenths of an inch in bore; which are connected together like a siphon, by a small bent glass tube *a b*, the bore of which is one-tenth of an inch in diameter. On the upper end of the leg A B there is a tube of latten brass, which is kneed or bent perpendicularly outwards, and has its mouth open towards F; on the other leg C D is a cover, with a round hole G in the upper part of it, two-tenths of an inch in diameter. This cover and the kneed tube are connected

together by a slip of brass, *c d*, which strengthens the whole instrument, and serves to hold the scale H I. The kneed tube and cover are fixed on with hard cement, or sealing-wax. To the same tube is soldered a piece of brass, *e*, with a round hole in it, to receive the steel spindle K L, and at *f* another such piece of brass is soldered to the brass hoop *g h*, which surrounds both legs of the instrument. There is a small shoulder on the spindle at *f*, upon which the instrument rests, and a small nut *i*, to prevent it from being blown off the spindle by the wind. The whole instrument is easily turned round upon the spindle by the wind, so as always to present the mouth of the kneed tube toward it. At the end of the spindle there is a screw, by which it may be screwed to the top of a post or stand: it has also a hole at L, to admit a small lever for screwing it into wood with greater facility. A thin plate of brass *k* is soldered on the kneed tube, about half an inch above the round hole G, so as to prevent rain from falling into it. There is also a crooked tube A B (*fig. 10.*), to be put occasionally upon the mouth of the kneed tube F, in order to prevent rain from being blown into the mouth of the wind-gage, when it is left exposed to the rain.

This instrument serves to ascertain the force of the wind, by filling the tube half full of water, and pushing the scale a little up or down, till *o* upon the scale, when the instrument is held perpendicularly, be on a line with the surface of the water, in both legs of the wind-gage. The instrument being thus adjusted, hold it up perpendicularly, and turning the mouth of the kneed tube toward the wind, observe how much the water is depressed by it in one leg, and how much it is raised in the other. The sum of the two is the height of a column of water, which the wind is capable of sustaining at that time; and every body that is opposed to that wind, will be pressed upon by a force equal to the weight of a column of water, having its base equal to the surface that is opposed, and its height equal to the altitude of the column of water sustained by the wind in the wind-gage. Hence the force of the wind upon any body, where the surface opposed to it is known, may be easily found; and a ready comparison may be made betwixt the strength of one gale of wind, and that of another, by knowing the heights of the columns of water which the different winds were capable of sustaining. The heights of the column in each leg will be equal, provided that the legs are of equal bores; but unequal if their bores are unequal. For suppose the legs equal, and the column of water sustained by the wind to be three inches, the water in the leg which the wind blows into will be depressed $1\frac{1}{2}$ inch below *o*, and raised as much in the other leg. But if the bore of the leg which the wind blows into be double that of the other, the water in that leg will be depressed only one inch, whilst it is raised twice as much, or two inches, in the other, and *vice versa*.

The force of the wind may likewise be measured with this instrument, by filling it till the water runs out at G. For if it be then held up to the wind as before, a quantity of water will be thrown out; and if both legs of the instrument are of the same bore, the height of the column sustained will be equal to double the column of water in either leg, or the sum of what is wanting in both legs. But if the legs are of unequal bores, neither of these will give the true height of the column of water which the wind sustained. For, obtaining in this case the true height, Dr. Lind has subjoined the requisite formulæ. The use of the small tube of communication *a b* (*fig. 9.*), is to check the undulation of the water, so that the height of it may be read off from the scale with ease and certainty; and also to prevent the

water from being thrown up to a much greater or less altitude than the true height of the column which the wind is able at that time to sustain. The author has calculated a table, by means of which, having the height of the column of water sustained in the wind-gage, the force of the wind upon a foot square may be determined.

Height of the Water in the Gage.	Force of the Wind on One Foot Square in Pounds Avoirdupois.	Common Designations of such Winds.
Inches.		
12	62.500	
11	57.293	
10	52.083	Most violent hurricane.
9	46.875	
8	41.667	Very great hurricane.
7	36.548	Great hurricane.
6	31.750	Hurricane.
5	26.041	Very great storm.
4	20.833	Great storm.
3	15.625	Storm.
2	10.416	Very high wind.
1	5.208	High wind.
0.5	2.604	Brisk gale.
0.1	0.521	Fresh breeze.
0.05	0.260	Pleasant wind.
0.025	0.030	A gentle wind.

When the height of the water is not exactly mentioned in the table, then that height may be separated into such parts as are mentioned in the table, and the sum of the forces answering to such parts will be the force of the wind correspondent to the height in question: thus, if the height of the water be 4.6 inches; then this height is equal to 4 + 0.5 + 0.1, which parts are all in the table; therefore,

Inches.	Pounds.
4	20.833
0.5	2.604
0.1	0.521

The sum is 23.958, which expresses the force of the wind when the height of the water in the gage is 4.6 inches.

Any alteration that can usually take place in the temperature of the water, makes no sensible difference in this instrument.

In frosty weather this gage cannot be used with common water. At that time some other liquor must be used, which is not so subject to freeze; and, upon the whole, a saturated solution of common salt in water is the most eligible: but in that case, (since the specific gravity of a saturated solution of salt is to that of pure water, as 1.244 to 1,) the forces which are stated in the preceding table must be multiplied by 1.244. Thus, if in the preceding example the saturated solution of salt had been used instead of water only, the force of the wind on a square foot would have been 29.8 pounds.

When salt-water is used, the force of the wind, which is stated in the table, must be increased in the proportion of the specific gravity of salt-water to that of common water; thus, using the preceding example, we must say, as 1 : 1.244 : : 23.958 to a fourth proportional, which must be found by

multiplying the second term by the third, and then dividing the product by the first term; but, the first term being unity, we need only multiply 23.958 by 1.244.

On the 9th of May, 1775, Dr. Lind observed, that the wind supported a column of water in his wind-gage 6 $\frac{7}{10}$ inches in height; and from his table it appeared, that the force of the wind in this hurricane, which did great damage to the gardens in his neighbourhood, was equal to 34.921 pounds avoirdupois, on every square foot.

If the velocity and density of the wind in any particular case were accurately determined, this instrument, which gives its force or momentum, would enable us to ascertain the velocity in every other case, the density being known: for the force of the wind is as the square of its velocity. Phil. Trans. vol. lxxv. part ii. art. 34. p. 353, &c.

Mr. Martin, from a hint first suggested by Dr. Burton, contrived an anemoscope, or wind-gage, of the following construction. A B C D E F G H I (fig. 11.) is an open frame of wood, firmly supported by the shaft or postern I. In the two cross pieces H K, L M, is moved an horizontal axis Q M, by means of the four sails *a b, c d, e f, g h*, in a proper manner, exposed to the wind. Upon this axis is fixed a cone of wood M N O, upon which, as the sails move round, a weight S is raised by a string on its superficies, proceeding from the small to the largest end N O. Upon the great end or base of the cone is fixed a ratchet-wheel *i k*, in whose teeth falls the click X, to prevent any retrograde motion from the depending weight.

From the structure of this machine, it is easy to understand, that it may be accommodated to estimate the variable force of the wind, because the force of the weight will continually increase, as the string advances on the conical surface, by acting at a greater distance from the axis. And, therefore, if such a weight be put on, on the smallest part at M, as will just keep the machine in equilibrio with the weakest wind; then as the wind becomes stronger, the weight will be raised in proportion, and the diameter of the base of the cone N O may be so large in comparison of that of the smaller end or axis at M, that the strongest wind shall but just raise the weight to the great end.

Thus, for example, let the diameter of the axis be to that of the base of the cone N O as 1 to 28; then if S be a weight of one pound at M on the axis, it will be equivalent to twenty-eight pounds, or $\frac{1}{4}$ of an hundred, when raised to the greatest end. If, therefore, when the wind is weakest, it supports one pound on the axle, it must be twenty-eight times as strong to raise the weight to the base of the cone. Thus may a line or scale of twenty-eight equal parts be drawn on the side of the cone, and the strength of the wind will be indicated by that number therein from which the string shall at any time hang.

Furthermore, the string may be of such a size, and the cone of such a length, that there shall be sixteen revolutions of the string between each division of the scale on the cone; so will the strength of the wind be expressed in pounds and ounces. And if greater exactness be required, let the periphery of the cone's base be divided into sixteen equal parts; then whenever the equilibrium happens, the string will leave the conic surface against one of those divisions, and thus shew the force of the wind to a drachm avoirdupois weight. Martin's Phil. Brit. vol. ii. p. 211, &c.

M. Bouguer contrived a very simple instrument, by means of which we may immediately discover the force which the wind exerts on a given surface. This is a hollow tube A A B B (fig. 12.), in which a spiral string C D is fixed, that may be more or less compressed by a rod F S D, passing

passing through a hole within the tube at A A ; then having observed to what degree different forces or given weights are capable of compressing the spiral, mark divisions on the rod in such a manner, that the mark at S may indicate the weight requisite to force the spring into the situation C D ; afterwards join at right angles to this rod at F, a plane surface E F E of a given area, either greater or less, at pleasure ; then let this instrument be opposed to the wind, so that it may strike the surface in the directions V E, V E, parallel to that of the rod, and the mark at S will shew the weight to which the force of the wind is equivalent.

The ingenious professor Leslie (Enquiry into the Nature and Propagation of Heat) having found, in the course of his experiments on heat, that the refrigerant, or cooling power of a current of air, is exactly proportional to its velocity, derives from this principle the construction of a new and simple anemometer. "It is in reality nothing more," says he, "than a thermometer, only with its bulb larger than usual. Holding it in the open still air, the temperature is marked: it is then warmed by the application of the hand, and the time is noted which it takes to sink back to the middle point. This I shall term the fundamental measure of cooling. The same observation is made on exposing the bulb to the impression of the wind, and I shall call the time required for the bisection of the interval of temperatures, the occasional measure of cooling. After these preliminaries, we have the following easy rule: Divide the fundamental by the occasional measure of cooling, and the excess of the quotient above unit, being multiplied by $4\frac{1}{2}$, will express the velocity of the wind in miles *per* hour. The bulb of the thermometer ought to be more than half an inch in diameter, and may, for the sake of portability, be filled with alcohol, tinged, as usual, with archil. To simplify the observation, a sliding scale of equal parts may be applied to the tube. When the bulb has acquired the due temperature, the zero of the slide is set opposite to the limit of the coloured liquor in the stem; and after having been heated, it again stands at 20° in its descent, the time which it thence takes until it sinks to 10° is measured by a stop-watch. Extemporaneous calculation may be avoided, by having a table engraved upon the scale for the series of occasional intervals of cooling."

WIND-Gall, a disease in horses and some other animals. It is a puffy kind of swelling or tumour, which yields to the pressure of the finger, but upon removing the pressure recovers itself, and pushes out as before. These swellings have been thus named from a false notion of their containing nothing but air or wind. These tumours are often seated on both sides of the back-sinew of a horse, above the fetlock on the fore-legs, but most frequently on the hind-legs. They are quite loose and detached from the parts on which they grow, and exhibit the same signs wherever they are met with, whether in the hocks or about the knees; for these swellings are not confined to the lower limbs only, but appear in any of those parts of a horse's body where the cellular membrane can be easily separated; and they exist, for the most part, without occasioning any pain. They are usually caused by riding on very hard roads, or on dry hilly grounds. Sometimes travelling horses, when they are worked too young, before the limbs are grown firm and vigorous, will have them. And Gibson observes, that they sometimes proceed from constitutional weakness, especially in bulky horses, that are somewhat under-limbed and fleshy about the fetlock-joint. These, it is said, have been known to have wind-galls without any strain, hard riding, or other ill usage of any kind.

It has been observed too, that when these tumours appear upon the hind-legs they never cause lameness, though such horses are often stiff behind after riding. When on the fore-legs they always make a horse go lame at first; but afterwards that tenderness goes off in a great measure, and they seldom go lame, but stiff, and inclinable to stumble. They generally recover, however, with a day's rest. Those flatulent swellings indeed that come in the ligaments of the hocks are always troublesome, disfigure the animal, and, unless speedily assisted, will cause incurable lameness. At first they are but small, but in time they grow to the size of a pullet's egg, perhaps, and push out on each side of the hollow of the hock. Swellings of the same kind also appear before the knee, where they often precede a diseased joint. Very small similar swellings under the fore part of the knee, in the interstices of both sides of the joint, are also dangerous; but these seldom happen, and are usually caused by some violent strain, especially when a horse falls down upon a descent with his whole weight upon his knees. The other flatulent swellings which horses are subject to seldom cause lameness, but are, for the most part, easily cured. We mean those that arise in the interstices of the large muscles of the hips and thighs, which are distended like little bladders filled with air. These come by strains and over-exertion; for draught-horses are the most subject to them.

Wind-galls that proceed from mere weakness are seldom curable, unless the constitution can be improved; but we often see horses that were subject to wind-galls when young, get the better of them as they advance in age. The methods of cure in these cases is by means of blistering, firing, and the use of astringent applications.

As these are enlargements of the capsules, or *bursæ mucose*, situated between the tendons, that contain an oily lubricating fluid for the prevention of friction and to facilitate motion, arising from long exertion producing inflammation of them, and an increased secretion of the contained fluid, they are capable of being easily removed in their beginning states, by rest and the use of blisters to the parts composed of cantharides and corrosive sublimate with olive oil; afterwards turning the animals out to grass or the straw-yard. Or where this cannot be permitted, the parts may be strengthened by the use of a flannel roller, made and continued wet by a wash composed of equal parts of strong vinegar and Goulard water, or the latter alone in some cases. If, however, the disease may have been neglected, recourse must be had to the hot iron; after which the blistering should be practised as before advised.

WIND-Gun. See **AIR-Gun**.

WIND-Hatch, in *Mining*, a term used to express the place at which the ore is taken out of the mines.

The word *hatch* is the general term used by the miners to express an opening from the surface into the mine, or in the attempting to find a mine.

Thus the word *essay-hatches* signifies the openings made in search of the trains of shoad-stones; and the *tin-hatch* in Cornwall is the name of the opening by which they descend into a tin-mine.

The word *wind-hatch* seems to be a corruption of *winder-hatch*; for at these places they have a winder conveying two buckets, the one constantly up, the other constantly down; the man below fills the bucket that descends; and when that which ascends full is emptied at the mouth of the hatch, the person who has the care of that part of the work, delivers it empty to go down again. Phil. Trans. N^o 69.

WIND-Hover, in *Ornithology*, the name of a species of hawk,

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hawk, called also by some the *flannel*, but more usually the *kefrel*, and known among authors by the names of the *tinnunculus* and *cenchris*.

WIND-Instruments, in *Music*, are instruments played by wind, chiefly by the breath; in contradistinction to stringed-instruments, and instruments of the *pulsative* kind.

The wind-instruments known to the ancients were, the *tibia*, *fistula*, or *syringa* of Pan, consisting of seven reeds, joined sidewise; also, *organs*, *tuba*, *cornua*, and the *lituus*. Those of the moderns are, the *flute*, *bagpipe*, *hautboy*, *trumpet*, &c. See INSTRUMENT, and MUSIC.

WIND-Mill, in *Mechanics*, a machine which is put in motion by the force of the wind. Wind-mills are in general applied to the purpose of grinding corn, but are occasionally used to give motion to machines for raising water, sawing-mills, or for other purposes. We shall in this article consider the wind-mill as a first mover, or *primum mobile*, which may be applied to many purposes.

The invention of wind-mills is not of very remote date. According to some authors they were first used in France in the sixth century; while others maintain that they were brought to Europe in the time of the crusades, and that they had long been employed in the East, where the scarcity of water precluded the application of that powerful agent to machinery.

The wind-mill, though a common machine, has some things in it more ingenious than is usually imagined. Add, that it is commonly allowed to have a degree of perfection, which few of the popular engines have attained to, and which the makers are but little aware of: though the aid of mathematics has furnished ample matter for its improvement.

The vertical wind-mill, which is the kind in most common use, consists of an axis or shaft A B, (*fig. 1. Plate II. Wind-Mill*), placed in the direction of the wind, and usually inclining a little upwards from the horizontal line. At one end of this, four long arms or yards, S, T, V, W, are fixed perpendicular to the axis, and cross each other at right angles; into these arms small cross-bars are mortised at right angles; and other long bars are joined to them, which are parallel to the length of the arms; so that the bars intersect each other in the manner of lattice-work, and form a surface, on which a cloth can be spread to receive the action of the wind. These are called the sails; they are in form of a trapezium, and are usually nine yards long and two wide.

The circular motion is produced by the obliquity of the planes of these surfaces, from the plane in which all the four arms are situated; by these means, when the wind blows in the direction of the axis, it does not impinge upon the sails at right angles to their surfaces, but strikes obliquely; hence the effort of the sail to recede from the wind, causes it to turn round with the common axis, and the four sails are all made oblique in the same direction, so as to unite their efforts for the common object.

That the wind may act with the greatest efficiency upon the sails, the wind-shaft must have the same direction as the wind. But as this direction is perpetually changing, some apparatus is necessary for bringing the wind-shaft and sails into their proper position: this is done by turning the axis and sails round in an horizontal direction. There are two methods of effecting this. In the old mills, like *fig. 1*, the whole of the mill or building which contains the machinery is sustained upon a vertical post, firmly fixed as a stand or foot, upon which the whole machine can be turned by a lever, to present the sails to any quarter of the horizon from whence the wind blows; and hence these are called post wind-mills, and are necessarily made of wood. The other kind, *fig. 2*, is called a

smock-mill, in which only the dome-cap or head, which contains the axis of the sails, and covers the great cog-wheel, turns round horizontally; the other parts of the machinery being contained in a fixed building, which rises up in form of a conical tower of masonry, and is surmounted by this moveable cap or dome, which is supported on rollers, so as to turn round easily.

As both the common methods of adjusting the wind-shaft require human assistance, it would be very desirable that the same effect should be produced solely by the action of the wind. This may be done by fixing a large wooden vane or weathercock at the extremity of a long horizontal arm, which lies in the same vertical plane with the wind-shaft.

By these means, when the surface of the vane and its distance from the centre of motion are sufficiently great, a very gentle breeze will exert a sufficient force upon the vane to turn the machinery, and will always bring the sails and wind-shaft to their proper position. This weathercock, it is evident, may be applied either to machines which have a moveable roof, or to those which revolve upon a vertical arbor. This method is practised in small machines; but a vane of sufficient power to turn a large mill about would be unwieldy. A much better method is therefore practised in the best mills, as we shall soon describe.

In a *post-mill* the building must necessarily be of small size, and it can only contain one pair of mill-stones. For this purpose, a large cog-wheel is fixed upon the main-shaft or axis of the sails; the cogs are placed in the face or flat surface of the wheel, and act upon the teeth of a pinion, which is fixed upon the vertical axis or spindle of the mill-stones. The mill-house is of a rectangular figure, but narrow in the direction which is presented to the wind: it is two stories high, the main-shaft and mill-stones being in the upper chamber, whilst the lower is only used to contain sacks of flour, and also to receive the post on which the mill turns round horizontally to face the wind. This post is a very strong tree, and is held perpendicularly by fixing it upon the middle of long timbers, which form a large cross on the ground, and are the basement of the whole mill. The post is fixed perpendicularly by means of several oblique braces, extending from the ground-cross to the middle part of the post; but ten or twelve feet of the upper end of the post must be round, and clear from the obstruction of the braces. This part of the post rises up through the middle of the lower chamber, in the floor of which a circular collar is formed, to surround the lower part of the post exactly. At the upper end of the post is a pivot or gudgeon, which enters into a socket fixed in the middle of the upper floor, and to one of the strongest cross-beams, because this beam must sustain the whole weight of the mill. In this manner, the whole mill can turn about upon the vertical post, but remains always in equilibrio. To make it firm, and prevent it from turning about at every moment, a strong framing is united by joints to the back part of the mill-house, and descends in a sloping direction till it touches the ground: this is furnished with steps, so that it serves as a broad ladder to ascend to the mill; but another use is to steady the mill, because the end of this frame, which is very heavy, rests on the ground, and short posts are fixed in a circle round the mill at regular intervals, to which the end of the ladder is fastened with cords. In order to turn the mill about, a rope is fastened to the end of the sloping ladder, and is carried up to the top of the mill in an inclined direction. By means of a strong lever, or a tackle of pulleys, this rope can be shortened, so as to lift up the ladder clear of the ground; and then, by pushing it like a long lever, the whole mill is turned round. To obtain more force, a small capstan is often provided to draw a rope

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a rope attached to the end of the ladder. This capstan is moveable, and is fastened at pleasure to any one of the posts which are fixed in the ground.

The internal mechanism of a post wind-mill is exhibited in *fig. 3. Plate II. Wind-Mill.* A H O is the upper room; H o z the lower one; A B the axis passing through the mill; S, T, V, W, the sails, covered with canvas, set obliquely to the wind, and turning round in the order of the letters in *fig. 1*; C the cog-wheel, having about forty-eight cogs, which carry round the lantern E, having eight or nine rounds, together with its spindle G N; K is the upper mill-stone, and L the lower one; Q R is the bridge supporting the axis or spindle G N; this bridge is supported by the beams c and X Y, wedged up at c and Q; z Y is the lifting-tree, which stands upright; a b and e f are levers, whose centres of motion are a and u; f g h i is a cord, with a stone, i: it goes about the pins g and h, to wind up and raise the stone at pleasure. The spindle t N is fixed to the upper mill-stone K, by a piece of iron called the rynd, and fixed in the lower side of the stone, which is the only one that turns about, and its whole weight rests upon a hard stone, fixed in the bridge Q R at N. The trundle E, and axis G t, may be taken away; for it rests by its lower part at t by a square socket, and the top runs in the edge of the beam w. By bearing down the end f of the lever f e, b is raised, which raises z Y, and this raises Y X, which lifts up the bridge Q R, with the axis N G, and the upper stone K; and thus the stones are set at any distance. The lower immovable stone is fixed upon strong beams, and is broader than the upper one: the flour is conveyed through the tunnel n o into a chest; P is the hopper, into which is put the corn, which runs along the spout r into the hole t, and so falls between the stones, where it is ground. The axis G t is square, which shaking the spout r, as it goes round, makes the corn run out; r s is a string going about the pin s, and serving to move the spout nearer to or farther from the axis, so as to make the corn run faster or slower, according to the velocity and force of the wind. And when the wind is great, the sails S, T, V, W, are only in part or one side covered; or perhaps only one half of two opposite sails. Toward the end B of the axis another cog-wheel may be fixed, with a trundle and mill-stones, like that already described; so that the same axis moves two stones at once; and when only one pair is to grind, the trundle E, and axis G t, are taken out from the other; x y l is a girt or gripe of pliable wood, fixed at the end x; and the other end l is tied to the lever k m, moveable about k; and the end m being put down, draws the gripe x y l close to the cog-wheel; and thus the motion of the mill is stopped at pleasure; p q is a ladder for ascending to the higher part of the mill; and the corn is drawn up by means of a rope, rolled about the axis A B, when the mill is at work.

The structure of the mill-stones, or grinding parts, is the same as the water-mills. See MILL.

It is plain that this construction confines all the machinery to the two chambers, or that part of the mill which is poised upon the vertical post; hence this kind of wind-mill is unfit for any other purposes than that of grinding corn, and for expressing oil, because there is so little room for the machinery. The Dutch, who are famous for wind-mills, make them sometimes with a very large post, which has a hole down the centre of it, like a trunk, and through this, a perpendicular axis passes to convey the power of the mill down into a building below, and upon the top of which, as a roof, the foundation-beams of the

post are fixed. (See *fig. 4.*) In this way, the mill is applied to saw wood, or to make paper, or any other purpose; but the construction is complicated, and less effective than the other kind of mill, in which only the head or top turns round, as we shall now describe.

The Smock-Mill.—This is the best kind of mill, because the building which contains the machinery may be made of any required dimensions, the sails and turning cap being all at the top of the house. *Fig. 3. in Plate I. Wind-Mill,* is a vertical section of one of these mills. K K are the walls of the house, and O O strong timbers forming a roof to it; upon these eight principal timbers H are erected, to form an octagonal pyramid of carpentry, the sides of which are filled up by diagonal bracing, and small uprights to nail the boarding to.

The four sails are fixed on an iron axis B N, by screwing them to an iron cross formed at one end of it. Two of these sails are marked A A; but the other two are endways, and cannot be seen. Upon the axis within the mill the cog-wheel C is fixed; and this turns a trundle or lantern D, fixed on the upper end of a strong vertical shaft, E E, extending from the top to the bottom of the mill, to turn the machinery: on the lower end of it is a large wheel, f f, which turns two pinions, g g, upon the spindles of the mill-stones h h. These are on the same construction as those described in our article MILL, to which we refer. At l is a wheel upon the main axis, giving motion to a pinion on a horizontal shaft or roller, k, which has a rope wrapped upon it, to wind up the sacks of corn. The wheel l also turns a similar horizontal axis with several wheels, to receive endless ropes for turning the bolting and dressing machines.

We will now enter more fully into the mechanism of the upper part of the mill, which is called its head or cap, marked G, and contains the axis B N. This is supported upon bearings, one being near its sails, and the other at its extreme end, as is shewn in *fig. 5. Plate II. Wind-Mill,* which is an horizontal section of the head, shewing the circular kirk, or wooden ring, K, and the framing which is bolted upon it to support the axis.

The construction of the axis is shewn in *fig. 6.* of the same plate. It consists of an octagonal iron shaft with two cylindrical necks at e and d, where it rests upon its bearings. At the end it has a kind of box, which has two mortises, e and f, through it in perpendicular directions to receive the sails. At the back of one of these mortises, and the front of the other, a projecting arm is left in the casting to receive screw-bolts, which hold the sails fast in the mortises. The cog-wheel is fixed on by bolting its arms against a flanch C, cast on the axis. The sails are braced by a rope-stay to each arm, proceeding from the end of a pole, which is fixed at the end of the cast-iron axis. Each sail is formed of a sail-cloth, spread upon a kind of lattice-work or framing, composed of rails mortised into the arms of the sails. The plane of this frame is inclined to the plane of the sails' motion at such an angle, that the wind blowing in the direction of the axis acts upon the sails as inclined planes, and turns them about with a power proportionate to the size of the sails and force of the wind. It is necessary, as the wind changes its direction, to turn the sails about, that the axis may be always in the direction of the wind. (See *fig. 3. Plate I.*) This motion is effected by turning the head of the mill round upon the fixed part, on a circle or kirk at the top of the frame composing the house of the mill. At the bottom of the frame of the wood-cap is a circular or moveable kirk, between which and the fixed kirk a number of rollers are placed; and the moveable kirk of the cap lies upon these rollers, which are kept equidistant

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equidistant from each other by their centre-pins being fitted into a circular hoop : by these means, though the head of the mill with the wheels and sails weigh several tons, they can be made to turn round to face the wind by a slight power.

The head is contrived to turn itself about whenever the wind changes in the following manner :—A small pair of sails, or fans, *M*, are fixed up in a frame *L*, projecting from the back of the head : it has a pinion of ten leaves upon its axis, engaging in a wheel of 60 teeth upon an inclined axis *b* ; and this has a pinion *d* of 12 leaves at the other end of it, turning a bevelled wheel of 72 teeth upon a vertical iron axis, at the lower end of which is a pinion *e* of 11 teeth : this works in a circle of 120 cogs, fixed round on the outside of the fixed kirk. By these means, whenever the fan *M* is turned, it moves the head of the mill slowly round, and with proportionate power.

Now if ever the wind varies in the least from the direction of the main shaft of the sails, it acts obliquely upon the vanes of the fan, and turns them round, at the same time setting the head right again, so that the axis points to the wind. But when the axis is in this situation, the wind blows in the planes of the vanes of the fan, and has no effect upon them. The head of the mill is kept firmly in its place when it turns about by rollers ; the axles of which are bolted to the inside of the framing of the head, and the rollers apply to the inside of the fixed kirk : there are four of these rollers. The pivot at the upper end of the vertical shaft is supported in a bearing bolted to a cross-beam in the framing of the head of the mill ; and this is fixed precisely in the centre of the head, that it may not vary in its situation as the head turns round. Many other things are so evident in the drawing as to need little farther explanation ; such as the different floors of the building, and the circular gallery, *I I*, all round the mill, for the miller to go round to take the cloth off the sails in high winds, or when the mill is to stop. This is done by untying the cloth at the extremity of the sail, and twisting it up like a rope ; then tying the end of it again to the lattice, in which state it presents no surface to the wind. At *k* is a roller turned round by a wheel *l*, fixed on the middle part of the vertical shaft : it is used to draw up the sacks of corn from the bottom of the mill into the upper part, which is used as a store-house for the corn, being divided into as many compartments as the miller requires. The mill-stones are made the same as those used in water-mills. A pair of regulating balls are attached to the upper part of the mill-stone spindle, to regulate the velocity of the mill. The manner of applying this regulator is explained in *fig. 5. Plate II. Wind-Mill.* The lower end of the iron spindle *F* is fitted to a square, formed on the top of the mill-stone axis, and the pinion *g g* is fixed on the upper end, to give motion to the stones : immediately beneath the pinion two rods are jointed, hanging downwards, having a heavy iron ball, *l*, fixed fast on the lower end of each : two links are jointed to the arms at *m*, and suspend a collar, which is capable of sliding freely up and down upon the spindle *F*. It is evident that when the balls fly out from the spindle by their centrifugal force, that the collar will be elevated, and the contrary when the balls approach the spindle. The sliding collar is embraced by a fork formed at the end of a steelyard, lying horizontal, and suspended by the rod *p* as a fulcrum ; an iron rod *q* descends from the extreme end of the steelyard, having its lower end formed to a hook, by which it is connected with a lever, *r*, whose fulcrum is *s* ; this, by an iron rod *t*, suspends one end of the beam called the bridge, on which the lower pivot of the mill-stone axis rests, the other end bearing on a fulcrum or centre. Now it follows from this arrangement of levers, that by elevating the forked end

of the steelyard, or the sliding collar, that the spindle of the stones will be suffered to descend a very minute quantity. This regulates the velocity of the mill, because when the wind increases, and the motion of the mill is accelerated, the balls fly out by the centrifugal force ; this lets the upper stone down nearer to the lower, thereby increasing the resistance to the mill, and counteracting the increased force of the wind. On the other hand, if the wind falls, and the mill moves more slowly in consequence, the balls fall together, and let down the sliding collar ; this raises the stone up, and increases the distance between them, thereby diminishing the resistance ; for this purpose, a weight *o* (*fig. 5.*) is hung upon the steelyard, sufficient to elevate the stone whenever the closing of the balls and consequent descent of the collar will permit it to do so. There are several notches made in the steelyard for different positions of the fulcrum *p* and rod *q* ; by means of these the quantity of the regulation can be adjusted to the following rule. If when the wind blows stronger the mill goes slower, contrary to the effect expected, it shews that the regulation is too active ; then increase the leverage of the balls by shortening the distance between the fulcrum *p* of the steelyard and the suspension of the rod *q*, by shifting either of them into different notches. On the contrary, if the mill goes much faster when the wind increases, it shews that the regulation does not act sufficiently ; then increase the distance between the rod *q* and the fulcrum *p*. If the whole limits of the notches in the steelyard should not be sufficient to effect this, the acting length of the lever *r s* must be increased or diminished by removing its fulcrum *s* to a greater or lesser distance from the suspending-rod *t* ; by means of this contrivance the miller is enabled, without much inconvenience, to regulate the velocity of the stones to that degree which is found best for reducing the greatest quantity of grain to flour, without damaging it by heating, as is the case when the stones move too quick.

Theory of the Motion of a Wind-Mill, with the Position of its Sails or Vanes.—The angle which the surfaces of the sails are to make with their common axis, that the wind may have the greatest effect, or the degree of weathering, as the millwrights call it, is a matter of nice inquiry, and has much employed the thoughts of the mathematicians.

To conceive why a wind-mill moves at all, the theory of compound motions must be supposed. A body moving perpendicularly against any surface, strikes it with all its force. If it move parallel to the surface, it does not strike it at all ; and if it move obliquely, its motion, being compounded of the perpendicular and parallel motion, only acts on the surface, considered as it is perpendicular, and only drives it in the direction of the perpendicular. So that every oblique direction of a motion is the diagonal of a parallelogram, whose perpendicular and parallel directions are the two sides. Add, that if a surface, which, being struck obliquely, has only received the perpendicular direction, be fastened to some other body, so as that it cannot pursue its perpendicular direction, but must change it for some other ; in that case, the perpendicular itself becomes the diagonal of a new parallelogram, one of whose sides is the direction which the surface may follow ; and the other, that which it cannot.

Thus, a rudder fastened obliquely to the keel of a vessel, being struck by the current of water parallel to the keel, and, of consequence, obliquely with regard to itself ; it will appear, by drawing the line of perpendicular impulse, that it tends to tear the rudder from the keel, and to carry it away : and that this direction, perpendicular to the rudder,

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der, is oblique to the keel. The rudder, then, would be carried off in an oblique direction; but as, in reality, it is so secured, that it cannot be torn and carried off, we are only to consider, in this compound motion, that of the two directions wherewith it can move without being torn from the keel; and leave the other, which would tear it off, as useless.

Now, the direction in which it can move without parting from the keel, is that which carries it circularly about its extremity, as about a centre. So that the effect of the oblique impulse of the water on the rudder is reduced, first to a perpendicular impression, which is again reduced to the mere turning of the rudder round; or, if the rudder be immoveable, to the turning of the vessel. Now, in an oblique and compound motion, where only one of the directions is of service; the greater ratio the other has to it, the less effect will the motion have, and *vice versa*. In examining the compound motions of the rudder, we find, that the more oblique it is to the keel, the ratio of the direction that serves to turn it to the other is the greater. But, on the other hand, the more obliquely it is to the keel, and, of consequence, to the course of the water which is supposed parallel to it, the more weakly it strikes. The obliquity of the rudder, therefore, has, at the same time, both an advantage and a disadvantage; but as those are not equal, and as each of them is still varying with every different position of the rudder, they become complicated variously; so that sometimes the one prevails, and sometimes the other.

It has been a point of inquiry to find the position of the rudder, in which the advantage should be the greatest. M. Renau, in his famous theory of the working of ships, has found, that the best situation of the rudder is, when it makes an angle of fifty-five degrees with the keel. See RUDDER.

If, now, a wind-mill, exposed directly to the wind, should have its four sails perpendicular to the common axis in which they are fitted, they would receive the wind perpendicularly; and it is visible that impulse would only tend to overturn them. There is a necessity, therefore, to have them oblique to the common axis, that they may receive the wind obliquely.

For the greater ease, let us only consider one vertical sail. The oblique impulse of the wind on this sail is reducible to a perpendicular impulse; and that direction, as the sail cannot absolutely keep to it, is compounded of two; one of which tends to make it turn on its axis, and the other to fall backwards. But it is only the first of these directions that can be obeyed. Of consequence, the whole impulse of the wind on the sail has no other effect but to make it turn from right to left, or from left to right, as its acute angle turns this way or that. And the structure of the machine is so well contrived, that the three other sails are determined, from the same causes, to move the same way.

The obliquity of the sails, with regard to their axis, has precisely the same advantage and disadvantage with the obliquity of the rudder to the keel. And M. Parent, seeking, by the new analysis, the most advantageous situation of the sails on the axis, finds it precisely the same angle of fifty-five degrees.

For the farther illustration of this point, let A B (*Plate II. Wind-Mill, fig. 7.*) be the axis of the mill, C D a sail, and its angle of obliquity (*viz.* that which it makes with the axis) be E C G; then if G C be the force of the wind in the direct position of the sail, G E (the sine of the angle of incidence G C E) will be the force of the wind in its oblique position; but the force of G E is resolvable into two

others, E F and G F; of which the latter, being parallel to the axis, avails nothing in turning the sails about it; but the other, E F, being perpendicular to it, is wholly spent in compelling the sail to turn round. The force of the wind on the sail will be as the square of the sine of incidence, or as G E²; and if the area of the sail, and the velocity of the wind, be supposed constant, the force of the wind in the direct position will be to that in the oblique one, as G C to G E²; but when G E is the whole force, that part which turns the sail is represented by E F;

$$\text{and } G E : E F (:: G C : C E) :: G E^2 : \frac{C E \times G E^2}{G C}$$

= to the force which turns the sail, when the whole

$$\text{force is represented by } G E^2. \text{ This expression } \frac{C E \times G E^2}{G C}$$

begins from nothing, when the angle of incidence begins to be oblique, and increases with the obliquity of the said angle to a certain number of degrees; because that part of the force which is parallel to the axis, becomes less in proportion to that which is perpendicular to it; but after it has passed this limit, it again decreases, and becomes nothing, when the angle of incidence vanishes. There is, therefore, one certain position of the sail, in which the force of the wind upon it is a *maximum*. In order to find this, put radius G C = a, E C = x; and we have G E² = a a - x x, and consequently the

$$\text{force } \frac{C E \times G E^2}{G C} = \frac{a a x - x x x}{a}, \text{ which must be a } \textit{maxi-}$$

mum: therefore its fluxion $a a \dot{x} - 3 x^2 \dot{x} = 0$: whence

$$a a = 3 x x, \text{ and so } x = \sqrt{\frac{a a}{3}} = (\text{in logarithms})$$

$$\frac{20.000000 - 0.477121}{2} = 9.761439, \text{ which is the loga-}$$

rithmic sine of the angle $35^\circ 16' = C G E$; and therefore the angle E C G = $54^\circ 44'$, when the force of the wind is a *maximum*. Thus, also, if *lm* (*fig. 7.*) parallel to the axis Q M, be equal to a, and represent the whole force of the wind on the sail; this force is reduced to *ln*, and this again to *no*, which acts perpendicularly to the axis, and turns the sail. This force, putting *mn* = x,

$$\text{is expressed by } \frac{a a x - x^3}{a}, \text{ and thus, as before, when it}$$

$$\text{is a } \textit{maximum}, x = \sqrt{\frac{a a}{3}} = a \sqrt{\frac{1}{3}}; \text{ and the angle}$$

lmn = $54^\circ 44'$. *Martin's Phil. Brit. vol. i. p. 220, vol. ii. p. 212.*

This angle, however, is only that which gives the wind the greatest force to put the sail in motion, but not the angle which gives the force of the wind a *maximum* upon the sail when in motion: for when the sail has a certain degree of motion, it yields to the wind; and then that angle must be increased, to give the wind its full effect. Mr. Maclaurin, in his *Fluxions*, vol. ii. p. 734. has shewn how to determine this angle.

It may be observed, that the increase of this angle should be different, according to the different velocities from the axis to the extremity of the vane or sail. At the axis it should be $54^\circ 44'$, and thence continually increase, giving

the vane a twist, and so causing each rib of the vane to lie in a different plane.

It is observed, that the ribs of the vane or sail ought to decrease in length from the axis to the extremity, giving the vane a curvilinear form; so that no part of the force of any one rib be spent upon the rest, but all move on independent of each other. The twist above-mentioned, and the diminution of the ribs, are exemplified in the wings of birds. As the end of the sail nearest the axis cannot move with the same velocity which the tips or farthest ends have, although the wind acts equally strong upon them, Mr. Ferguson (Lect. on Mechanics, p. 52.) suggests, that perhaps a better position than that of stretching them along the arms directly from the centre of motion, might be to have them set perpendicularly across the farther ends of the arms, and there adjusted lengthwise to the proper angle. For, in that case, both ends of the sails would move with nearly the same velocity; and being farther from the centre of motion, they would have so much the more power, and then there would be no occasion for having them so large as they are generally made; which would render them lighter, and, consequently, there would be so much the less friction on the thick neck of the axle, when it turns in the wall.

M. Parent considered what figure the sails of a wind-mill should have, to receive the greatest impulse from the wind; and he determined it to be a sector of an ellipsis, whose centre is that of the axis, or arbor, of the mill; and the little semi-axis the height of thirty-two feet: as for the greater, it follows necessarily from the rule that directs the sail to be inclined to the axis, in an angle of 55 degrees.

On this foundation he assumes four such sails, each of which is one-fourth of an ellipsis; which, he shews, will receive all the wind, and lose none, as the common ones do. These four surfaces, multiplied by the lever with which the wind acts on one of them, express the whole power the wind has to move the machine, or the whole power the machine has when in motion.

The same manner of reasoning, applied to a common wind-mill, whose sails are rectangular, and their length about five times their breadth, shews, that the elliptic wind-mill has about seven times the power of the common one.

A wind-mill with six elliptic sails, he shews, would still have more power than one with only four. It would only have the same surface with the four, since the four contain the whole space of the ellipsis as well as the six. But the force of the six would be greater than that of the four, in the ratio of 245 to 231. If it were desired to have only two sails, each being a semi-ellipsis, the surface would be still the same; but the power would be diminished by near one-third of that with six sails, because the greatest of the sectors would much shorten the lever with which the wind acts.

Best Form and Proportion of rectangular Wind-Mills.—As elliptical sails would be something so new, that there is little room to expect they will come into common use, the same author has considered which form, among the rectangular ones, will be the most advantageous. And by the method *de maximis et minimis*, he finds it very different from the common ones.

The result of this inquiry is, that the width of the rectangular sail should be nearly double its length; whereas the length is usually made almost five times the width. Add, that as we call length the dimension which is taken from the centre of the axis, the greatest dimension of the new rectangular sail will be turned toward the axis, and the

smallest from it; quite contrary to the position of the common sails.

The power of a wind-mill with four of these new rectangular sails, M. Parent shews, will be to the power of four elliptic sails, nearly as 13 to 23; which leaves a considerable advantage on the side of the elliptic ones; yet will the force of the new rectangular sails be considerably greater than that of the common ones.

M. Parent likewise considers what number of the new sails will be most advantageous; and finds, that the fewer the sails, the more surface there will be, but the less power. The ratio of the power of a wind-mill with six sails will be to another with four, nearly as 14 to 13. And the power of another with four will be to that with two, nearly as 13 to 9.

For a variety of curious experiments and observations concerning the construction and effects of wind-mill sails, by the ingenious Mr. Smeaton, see Phil. Trans. vol. ii. p. 138, &c.

Mr. Smeaton's experiments did not realize M. Parent's theory; for he found the sails fixed at the angle of 55 degrees with the axis, to be the least advantageous of any which he tried; but if the sails are included from 72 to 75 degrees from the axis, or 15 to 18 degrees to the place of their motion, the greatest effect will be produced that can be when the sails are plane surfaces.

He also found, that the elliptical sails, which intercept the whole cylinder of wind, do not produce the greatest effect, for want of proper interstices for the wind to escape.

The following maxims, deduced by Mr. Smeaton from his experiments, contain the most accurate information upon the subject.

Maxim 1.—The velocity of wind-mill sails, whether unloaded or loaded, so as to produce a maximum effect, is nearly as the velocity of the wind, their shape and position being the same.

Maxim 2.—The load at the maximum is nearly, but somewhat less than, as the square of the velocity of the wind, the shape and position of the sails being the same.

Maxim 3.—The effects of the same sails at a maximum are nearly, but somewhat less than, as the cubes of the velocity of the wind.

Maxim 4.—The load of the same sails at the maximum is nearly as the squares, and their effects as the cubes of their number of turns in a given time.

Maxim 5.—When sails are loaded, so as to produce a maximum at a given velocity, and the velocity of the wind increases, the load continuing the same: 1st, The increase of effect, when the increase of the velocity of the wind is small, will be nearly as the squares of those velocities. 2^{dly}, When the velocity of the wind is double, the effects will be nearly as 10 to 27½. But, 3^{dly}, When the velocities compared are more than double of that where the given load produces a maximum, the effects increase nearly in the simple ratio of the velocity of the wind.

Maxim 6.—In sails where the figure and positions are similar, and the velocity of the wind the same, the number of turns in a given time will be reciprocally as the radius or length of the sail.

Maxim 7.—The load at a maximum that sails of a similar figure and position will overcome, at a given distance from the centre of motion, will be as the cube of the radius.

Maxim 8.—The effects of sails of similar figure and position are as the square of the radius.

Maxim 9.—The velocities of the extremities of the sails, in all their usual positions, when unloaded, or even loaded

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loaded to a maximum, are considerably quicker than the velocity of the wind.

Rules for modelling the Sails of Wind-Mills.—Fig. 4. Plate II. *Wind-Mill*, is a front view of one of the four sails of a wind-mill. The letters of reference will serve to explain the terms made use of in the following description.

1. The length of the arm or whip A A, reckoned from the centre of the great shaft B, to the outermost bar 19, governs all the rest.

2. The breadth of the face of the whip A, next the centre, is one-thirtieth of the length of the whip; its thickness at the same end is three-fourths of the breadth; and the back-side is made parallel to the face for half the length of the whip, or to the tenth bar; the small end of the whip is square, and as its end is one-sixtieth of the length of the whip, or half the breadth at the great end.

3. From the centre of the shaft B, to the nearest bar 1 of the lattice, is one-seventh of the whip; the remaining space of six-sevenths of the whip is equally divided into nineteen spaces, so as to make nineteen bars; one-ninth of one of these spaces is equal to the mortises for the bars, the tenons of which are made square where they enter and go through the whip, and consequently the mortises must be square also.

4. To prepare the whip for mortising, strike a gage-score at about three-fourths of an inch from the face on each side, and the gage-score, on the leading side 4, 5, will give the face of all the bars on that side; but on the other side, the faces of all the bars will fall deeper than the gage-score, according to a certain rule. To find the space to be set off for this purpose for each bar, construct a scale in the following manner.

5. Extend the compasses to any distance at pleasure, so that six times that extent may be greater than the breadth of the whip at the seventh bar; set those six spaces off upon a straight line for a base, at the end of which raise a perpendicular; set off three spaces upon the perpendicular, and divide the two spaces that are farthest from the base line into six equal parts each, so that this quantity of two spaces may be equally divided into twelve spaces marked out by thirteen points; from each of these points draw a line to the opposite end of the base, as so many rays to a centre, and the scale is finished.

6. To apply this scale to any given case, set off the breadth of the whip at the last bar, (that is, the bar at the extremity of the sail,) from the centre of the scale along the base towards the perpendicular; and at this point raise a perpendicular to cut the ray nearest to the base; also set off the breadth of the whip at the seventh bar in the same manner, and at this point erect another perpendicular to cut the thirteenth radius. From the intersection of the perpendicular (drawn upon the breadth of the last bar) with the first of the thirteen radii, to the intersection of the other perpendicular with the thirteenth radius, draw an oblique line cutting all the rest, and the distances of each of these last-mentioned points of intersection from the base line is the space which the face of each bar is distant from the gage-line on the driving side.

7. These distances give a different set-off for each bar till the seventh, which same must be set off for all the rest to the first.

8. The mortises must be square to the leading side of the whip.

9. When the mortises are cut, let the face of the whip be sloped off so as to agree with the face of the bars in every part.

10. Two-fifths of the whip are the length of the last or longest bar.

11. Five-eighths of the longest bar must be on the driving side of the whip, and three-eighths on the leading side, each being reckoned from the middle of the whip.

12. The proportion of the mortises already given determines the size of the bars at the mortises, but their thickness must be diminished each way, so as to be only one-half at the ends; but the face must be kept of equal breadth all the way.

13. The leading side goes no farther than the fourth bar, and there only projects one-third of the projection of the last bar.

14. All the bars on the driving side are made hollowing in the arch of a circle, which begins to spring one-third of the length of the bars on the driving side from the whip; and the sweep is such, that if a straight line is applied to the face of the bar from the whip to the end, the face of the bar should leave the straight line about the breadth of the bar.

15. There ought to be three uplongs, as 3, 2, 10, *fig. 4*, to the driving, and two to the leading side, as at 5, 4, to strengthen the lattice.

Self-regulating wind-mills are those which adapt themselves to the irregularities of the wind, by diminishing or increasing the surface on which the wind can act to turn them round. If the wind increases in force, the surface exposed to its action is diminished; on the contrary, if it decreases in force, the surface will be increased in the same proportion, so as in some measure to render their motion uniform.

The following self-regulating wind-mill is stated as the invention of Mr. Andrew Mickle in 1772, the inventor of the threshing-machine. The length of the sail was divided into eleven compartments, by the bars forming a number of oblong openings, which were each filled up by a square frame of wood covered with canvas, and mounted on pivots at their ends; one pivot turning in a hole in the whip, and the other in the bar which lies parallel to it, in the manner of a Venetian blind: the pivots were not placed in the middle of the breadth of the frames, but at one-third from that edge, towards the shaft or axis of the sails. On the end of each pivot which enters the whip a small roller is fixed, round which a chain passes, and its end is attached to a steel spring, placed at right angles to the whip, and in the direction of the length of the canvassed frames. Now, if the wind blows too hard, it acts to turn the frames edgewise, in which case the wind passes through the sails, and exerts less force to turn them round; but as soon as the wind becomes moderate, the steel spring brings up the frames into a plane, presenting their whole surface to its action. A rod of iron extends the whole length of the whip, and is connected with the several springs, to afford the means of strengthening or diminishing their action, according to the season of the year. This rod was formed into a screw at its outer extremity, and a nut put on to enable the miller to adjust the strength of the springs conveniently, from the circular gallery surrounding the outside of the mill.

Mr. William Cubit of North Walsham, in the county of Norfolk, took out a patent, in 1807, for a method of equalizing the motion of wind-mill sails. It is similar to Mr. Mickle's, in the sails being made like a Venetian blind; but instead of the springs, he applied racks and pinions on the ends of the blind pivots, and a sliding rod, which passed in a small hole made through the length of the axis of the sails; the end of this rod within the mill was

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made into a rack, working in a wheel upon which a weight was hung. By this means, when the wind blows too hard, the blinds turn upon their pivots, and by the racks draw out the rod which passes through the axis, and raise the weight; but as soon as the wind abates, the weight brings the blinds to their former position.

A patent was granted in 1804 to Mr. John Bywater of Nottingham, for a method of clothing and unclothing the sails of wind-mills while in motion. The invention consists in a manner of rolling or folding up, and unfolding again, the cloths of common wind-mill sails while in motion. It is effected by placing a long roller in the direction of the length of the whip round which the cloth is rolled; the inner end of the roller is furnished with a pinion, which engages in the teeth of a circular ring of cogs fixed to the shaft-head, close behind the back-stocks, with the liberty of turning round independent of the shaft. Another roller is placed at the back-side of the sail, round which several cords pass, and are conveyed over pulleys at the edge of the sail, and then made fast to the cloth at different distances along its length. The object of this second roller is to clothe the sail, in the same manner as the first-mentioned roller unclothed it. The inner end of the back roller is furnished with a bevelled pinion, which acts in the teeth of a ring of cogs placed concentric with the one before described, which has also the liberty of turning round independent of the shaft. Suppose the sails to be completely clothed, and turning round by the wind, the two rings of cogs revolve with the axis, and therefore produce no effect on the pinions; but if the wind blows too violent, and it becomes necessary to partly unclothe the sails, the miller pulls a cord which is connected with a lever in the head of the mill. This lever comes in contact with a projection on the ring of cogs belonging to the rollers, upon which the cloth winds. Now it is evident, that if the ring of cogs is held fast, and the sails continue to revolve, it will cause the pinions to turn round and roll up the cloth upon the rollers; on the contrary, if the wind falls, the sails will require to be more clothed, which is effected by the same lever being moved farther, so as to quit the ring of cogs it held before, and hold the other fast, which will put the rollers at the back of the sails in motion, and by winding the cords upon them, draw the cloth off the sail-roller, which increases the surface for the wind to act upon. We have not entered into the minute details of this invention, as given in the patent, for it would have exceeded our limits, but only given a sufficient description to enable a person to understand the means of effecting the regulation.

Horizontal Wind-Mills.—These are of various kinds; but only one kind that we know of has been put to any valuable use.

Horizontal wind-mills were a favourite speculation a century ago; and the *Theatrum* of the celebrated Leopold contain a great variety, but they are all upon one or other of two principles. In one of these, a very large wheel, like a water-wheel, is mounted with its axis in a perpendicular direction. It consists of several circular wheels fixed upon the axis; and it has large boards or vanes fixed parallel to its axis, and arranged at equal distances round the circular wheels. Upon these vanes the wind can act to blow the wheel round; but if the wind were to act upon the vanes at both sides of the wheel at once, it would have no tendency to turn the wheel round; hence one side of the wheel must be sheltered from the wind, whilst the other is submitted to its full action. For this purpose, the whole wheel is inclosed within a large cylindrical framing of wood,

which is furnished with doors or shutters on all sides to open at pleasure, and admit the wind, or to shut and stop it. If all the shutters on one side are open, whilst all those on the opposite side are shut, the wind, acting with undiminished force on the vanes at one side, whilst the opposite vanes are under shelter, turns the mill round; but whenever the wind changes, the disposition of the open vanes must be altered, to admit the wind to strike upon the vanes of the wheel in the direction of a tangent to the circle in which the vanes move. A horizontal wind-mill is thus described in Leopold's *Theatrum Machinarum* for grinding corn with one pair of stones. A strong upright axis is so poised on a pivot at the lower ends, and sustained in a collar or bearing, as to turn round. Into this several long arms are fixed, in the manner of radii, and at the extreme ends of each arm a vane is fixed, to receive the action of the wind. These vanes are made of two or more moveable leaves, which close up flat like a book, when they are at that side of the circle which moves in a direction to advance towards the wind; so that only the edges of the boards are opposed to the wind; but when these vanes arrive at the opposite side of the wheel, so that the wind blows upon them, the leaves fly open, and expose their full surfaces to the wind, and receive the impulse thereof.

A horizontal wind-mill is described by Dr. Hooke in the *Philosophical Collections* for 1681. It consisted of four vanes mounted upon vertical axes, and arranged round in a circle by the upper and lower pivots of the vanes being received into holes in the rims of two horizontal wheels fixed upon the same vertical shaft. The vanes were disposed in such a manner, that on one side of the wheel each vane presented its surface to the wind, whilst the one on the opposite stood edgeways, so as to move through the air without much resistance. This was effected by cog-wheels placed on the lower pivots of the vanes, and so arranged, that as one vane turned round upon its pivots, the whole number moved together, and the motion was given to them by a cog-wheel fixed fast to the framing over the wheel, but concentric with it. This wheel communicated, by means of an intermediate wheel, with the wheels on the axes of the vanes.

The action of this machine is as follows:—Suppose the wind blowing at the wheel; it acts against that vane which is at right angles to its motion, to turn the wheel round upon its axis. The opposite vane presenting its edge to the wind opposes very little resistance. The motion of the wheel upon its axis turns the vanes round upon their pivots, by means of the fixed cog-wheel before described; so that by the time that one has passed out of the direction of the wind, another arrives in the same perpendicular position; and when the wheel has made half a revolution, the vane which stood edgeways will be perpendicular to the wind, and the one which before stood perpendicular will be edgeways; thus a continued motion is produced without the wheel being cased up.

Horizontal wind-mills, which are inclosed in a house with blinds on all sides, are very fully described in Jacob Leopold's *Theatrum Machinarum*, 1724; but we believe they were first practised in this country by captain Hooper, who erected one at Margate, and another at Battersea. The latter is upon a very large scale, and is used for grinding corn; but at present it does not work with much advantage, as the repairs are more considerable in proportion to the power it exerts, than in the mills with sails constructed in the common manner.

In *Plate Wind-Mill*, fig. 1, is an upright section, and fig. 2.

a plan of the horizontal mill erected at Margate by captain Hooper. H H are the side walls of an octagonal building which contains the machinery. These walls are surmounted by a strong timber-framing G G, of the same form as the building, and connected at top by cross-framing to support the roof, and also the upper pivot of the main vertical shaft A A, which has three sets of arms, B B, C C, and D D, framed upon it at that part which rises above the height of the walls. The arms are strengthened and supported by diagonal braces, and their extremities are bolted to octagonal wooden frames, round which the vanes or floats E E are fixed, as seen in outline in *fig. 2*, so as to form a large wheel resembling a water-wheel, which is less than the size of the house by about eighteen inches all round. This space is occupied by a number of vertical boards or blinds F F, turning on pivots at top and bottom, and placed oblique, so as to overlap each other, and completely shut out the wind, and stop the mill, by forming a close case surrounding the wheel; but they can be moved all together upon their pivots to allow the wind to blow in the direction of a tangent upon the vanes on one side of the wheel, at the time the other side is completely shaded or defended by the boarding. The position of the blinds is clearly shewn at F F, *fig. 2*. At the lower end of the vertical shaft A A, a large spur-wheel *aa* is fixed, which gives motion to a pinion *c*, upon a small vertical axis *d*, whose upper pivot turns in a bearing bolted to a girder of the floor N. Above the pinion *c*, a spur-wheel *e* is placed, to give motion to two small pinions *f*, on the upper ends of the spindles *g* of the mill-stones *b*. Another pinion is situated, at the opposite side of the great spur-wheel *a a*, to give motion to a third pair of mill-stones, which are used when the wind is very strong; and then the wheel turns so quick, as not to need the extra wheel *e* to give the requisite velocity to the stones. The weight of the main vertical shaft is borne by a strong timber *b*, having a brass box placed on it to receive the lower pivot of the shaft. It is supported at its ends by cross-beams mortised into the upright posts *bb*, as shewn in the plan, *fig. 2*. A floor, or roof, I I, is thrown across the top of the brick building, to protect the machinery from the weather; and to prevent the rain blowing down the opening through which the shaft descends, a broad circular hoop K is fixed to the floor, and is surrounded by another hoop or case L, which is fixed to the arms D D of the wheel. This last is of such a size, as exactly to go over the hoop K, without touching it when the wheel turns round. By this means, the rain is completely excluded from the upper room M, which serves as a granary, being fitted up with bins *mm*, to contain the different sorts of grain which is raised up by the sack-tackle. A wheel *i* is fixed on the main shaft, having cogs projecting from both sides. Those at the under side work into a pinion on the end of the roller *k*, which is for the purpose of drawing up sacks. Another pinion is situated above the wheel *i*, which has a roller projecting out over the flap-doors seen at *p*, in the *fig. 2*, to land the sacks upon. The two pinions *mm*, *fig. 2*, are turned by the great wheel *aa*, and are for giving motion to the dressing and bolting machines, which are placed upon the floor N, but are not shewn in the drawing, being exactly similar to the dressing-machines used in all flour-mills. The cogs upon the great wheel *a* are not so broad as the rim itself, leaving a plain rim about three inches broad. This is encompassed by a broad iron hoop, which is made fast at one end to the upright post *b*; the other being jointed to a strong lever *n*, to the extreme end of which a purchase *o* is attached, and the fall is made fast to iron pins on the top of a frame fixed to the ground.

This apparatus answers the purpose of the brake or gripe used in common wind-mills to stop their motion. By pulling the fall of the purchase *o*, it causes the iron strap to embrace the great wheel, and produce a resistance sufficient to stop the wheel. The mill can be regulated in its motion, or stop entirely, by opening or shutting the blinds F, which surround the fan-wheel. They are all moved at once by a circular ring of wood situated just beneath the lower ends of the blinds upon the floor I I, being connected with each blind by a short iron link. The ring is moved round by a rack and spindle, which descend into the mill-room below, for the convenience of the miller.

A sort of wind-mill has been long much employed in Portugal, in which, from the difference in the construction of the sails, it is supposed by some, as lord Somerville, who has inspected it when working, to possess a superiority in having the broad part of the sail at the end of the levers or booms; in consequence of which equal resistance is overcome with less length of branches: and that from this shortness a considerable saving is made in the timber of both the booms and spindles, as well as in the height, first cost of the mills, and their future repairs.

The advantages of making use of these sorts of wind-mills in preference to others are, that as there are four booms, as well as four masts for the sails, they are capable of being more easily braced out to the wind, and in case of a sudden gale or gust of it, are more easily cast loose than in those of the common construction; and that as the sails in these mills are placed in the best possible direction by the booms, it is presumed that a wind-mill built on this plan and principle will do more work than any common wind-mill with an equal quantity of canvas.

These sorts of mills have also lately been very much improved by constructing and disposing those surface parts upon which the wind is intended to act, in such a particular manner, as that by alternately opposing a resisting and non-resisting surface, the whole force or impulse may operate in a direct manner upon the resisting side of the sail or vane, in proportion to its extent; and that when the non-resisting side is returning against these powers, the mill being so contrived that there is very little resistance, however large the surface. These improvements, when applied to horizontal wind-mills, the power of them, even with the same quantity of sail, or acting surface, may too be increased or diminished at pleasure, which is a circumstance of very great utility and convenience in many cases.

WIND-Pump, that sort of pump which is so contrived and formed as to be driven by the wind. These kinds of pumps are very useful for draining and lifting water in many cases, as where the depth of it is too great to admit of cutting drains, or the superstrata too loose for forming them, and when the height to which the water is to be raised is great. See **SPRING-Draining** and **SURFACE-Draining**.

WIND-Row, in *Agriculture*, a term signifying the green parts or borders of a field, dug up, in order to carry the earth on other land to mend it; so called because it is laid in rows, and exposed to the wind. It also signifies a row of peats set up to dry for fuel. Likewise a row of hay exposed to the wind and sun to get dry. And also of turfs or sward cut up in paring and burning.

The peats are set up in these rows in an open manner, to the height of two or three feet or more, that the wind may pass between and dry them. The rows of hay of this kind are either single or double, the former for that which is in the more grassy state, and the latter for that which has been more made; and the work is performed by different persons raking

raking the spread hay in opposite directions towards themselves, and by such means forming a row between them of double the extent of that of the single wind-row. See *HAY-Making*.

The turf or sods for burning are set up in these rows, in leaning directions against each other, so as to let the wind readily pass among and dry them in a quick manner for burning.

Whins are sometimes, too, formed into wind-rows for being burnt for the ashes. See *WHIN-Asbes*.

WIND-Sail, or *VENTILATOR*, in a *Ship*, is made of canvas, and used for circulating fresh air between the decks, and is in the form of a cylinder, or an obtuse-ending cone, and is adapted to the size of the ship. Four breadths of canvas are sewed together, and the outer selvages are joined with an inch seam, leaving one cloth four feet short of the top. A three-inch tabling goes round the top and bottom. It is kept distended by circular hoops, made of ash, sewed to the inside, one at top, and one at every interval of six feet. The upper part, or top, is covered with canvas, and a small rope sewed round the edge; into which are spliced, at the quarters, the ends of two pieces of rope, that are sewed up to the middle, and an eye formed by seizing the bights. The length of a wind-sail is taken nine feet above the deck, to three or four feet below the lower hatchway; the quantity of canvas is obtained by multiplying the number of cloths by the length.

These, of which there are generally three or four in our capital ships of war, have the advantage of taking little room, of requiring no labour in working, and of a simple contrivance, so that they can fail in no hands. But their powers are said to be small in comparison with those of Dr. Hales's ventilators: they cannot be put up in hard gales of wind, and are of no efficacy in dead calms, when a refreshment of air is most wanted. See *VENTILATOR*.

WIND-Seed, in *Botany*. See *ARCTOTIS*.

WIND-Shock, a name given by our farmers to a distemper to which fruit-trees, and sometimes timber-trees, are subject.

It is a sort of bruise and shiver throughout the whole substance of the tree; but the bark being often not affected by it, it is not seen on the outside, while the inside is twisted round and greatly injured.

It is by some supposed to be occasioned by high winds; but others attribute it to lightning. Those trees are most usually affected by it, whose boughs grow more out on one side than on the other.

The best way of preventing this in valuable trees, is to take care in the plantation that they are sheltered well, and to cut them frequently in a regular manner while young.

The winds not only twist trees in this manner, but they often throw them wholly down: in this case, the common method is to cut up the tree for firing, or other uses; but if it be a tree that is worth preserving, and it be not broken but only torn up by the roots, it may be proper to raise it again by the following method:—Let a hole be dug deep enough to receive its roots, in the place where they before were; let the straggling roots be cut off, and some of the branches, and part of the head of the tree; then let it be raised, and when the turn-up roots are replaced in the earth in their natural situation, let them be well covered, and the hole filled up with rammed earth; the tree will, in this case, grow as well, and perhaps better, than before. If nature be left to herself, and the tree be not very large, the pulling off the roots will raise it. Mortimer's Husbandry, vol. ii. p. 79.

WIND-Tackle Blocks, in a *Ship*. See *WINDING-Tackle*.

WIND-Taught, in *Sea Language*, denotes the same as stiff

in the wind. Too much rigging, high masts, or any thing catching or holding wind aloft, is said to hold a ship wind-taught; by which they mean, that she stoops too much in her sailing in a stiff gale of wind.

Again, when a ship rides in a main stress of wind and weather, they strike down her top-masts, and bring her yards down, which else would hold too much wind, or be too much distended and wind-taught.

WIND-Thrush, in *Ornithology*, a name given by some to the red-wing, and supposed to be given from their generally first appearing with us in windy seasons; but it appears more probably to be derived from the German name *wint-trossel*, or vine-thrush, from its doing great mischief there in the vineyards, by eating and destroying the grapes. Ray.

WIND-Tumours. See *TUMOUR*.

WIND-Ward, in *Sea Language*, denotes any thing towards that point from whence the wind blows, in respect of a ship.

WIND-Ward, Sailing to. See *SAILING*.

WIND-Ward Tide denotes a tide which runs against the wind.

WIND, in *Geography*, a river of America, which runs into the Connecticut at Windsor.

WIND Gap, a pass in the Blue Mountains of Pennsylvania.

WINDAGE of a Gun, is the difference between the diameter of the bore and the diameter of the ball.

The windage is not the same in England as it is abroad. With us, if the diameter of the shot is divided into twenty equal parts, then the diameter of the bore is twenty-one of these parts. The French suppose the diameter of the shot divided into twenty-six parts, and the diameter of the bore to be twenty-seven. Mr. Muller observes, that the less windage there is, the truer the shot will go, and having less room to bounce from one side to another, the gun will not be spoiled so soon. Accordingly, he divides the diameter of the shot into twenty-four equal parts, and makes the bore twenty-five, which is a medium between the English and French method. Artillery, p. 84.

Dr. Hutton observes, that if the windage be one-twentieth of the calibre, which is the usual size, no less than one-third or one-fourth of the powder escapes, and is lost. As the balls are often smaller than the regulated size, it frequently happens, that half the powder is lost by unnecessary windage.

Dr. Hutton also recommends the diminishing of the windage. See *GUNNERY*.

WINDALA, in *Geography*, a town of Sweden, in East Bothnia; 65 miles E. of Wala.

WINDALL, a town of the state of Vermont; 22 miles S.S.W. of Windsor.

WINDASS, *WANDASS*, or *WANLASS*, an ancient term in hunting. Thus, to drive the windass signifies the chasing of a deer to a stand, where one is ready with a bow, gun, or to shoot. This is one of the customary services of fiefs.

“—Omnes illi qui tenerunt in bondagii tenura, solebant vocari custumarii: & quotiescunque dominus ad venandum venerit, illi custumarii solebant fugare windassum, ad stabulum, in venatione ferarum bestiarum secundum quantitatem tenuræ suæ.” MS. de Consuetud. Manerii de Sutton Colfield, an. 3 Ed. II.

WINDAU, in *Geography*, a sea-port town of the duchy of Courland, near the mouth of the Wera, on the Baltic. It was the capital of a palatinate, and has a castle, once the residence of the Livonian knights; the states of Courland likewise held their assemblies here, which made it populous; but it is now much decayed, and chiefly supported by ship-building, and exporting pitch, tar, wax, &c.; 8 miles N.N.E. of Piltyn. N. lat. 57° 10'. E. long. 21° 32'.

WINDAU.

WINDAU. See WETA.

WINDECK, a town of France, in the department of the Scheldt; 9 miles S.S.E. of Ghent.—Also, a town of the duchy of Berg; 21 miles E. of Bonn.

WINDECKEN, a town of Germany, in the county of Hanau Munzenberg; 4 miles N. of Hanau.

WINDELSBACH, a town of the margravate of Anspach; 22 miles N.W. of Anspach.

WINDER, in *Agriculture*, a term used provincially to signify to clean corn with a fan-machine. See FAN-Machine.

WINDER-Meb, in *Ornithology*, the name of a bird of the larus, or gull-kind, the *larus cinerarius* of Linnæus, moderately large, and described by Aldrovandus under the name of *larus major*.

Its head is remarkably large and thick, and is of a mottled colour of white and grey; its breast and belly are also variegated with the same colours, but they are somewhat paler; its beak is thick and strong, of a yellow colour, and very sharp, and the opening of its mouth very wide; its wings are variegated with white, grey, and chestnut colour, and both these and the tail have much black in them; the feet are webbed and yellow, the claws are sharp, and the hinder toe larger than in most birds of this kind. Ray's *Zoology*, p. 267.

WINDERS of Wool. See WOOL-Winders.

WINDHAM, or WYMONDHAM, in *Geography*, a town of England, in the county of Norfolk, with a weekly market on Friday. The chief trade of the place is making wooden ware. In 1549, William Kett, one of the Norfolk insurgents, was hanged on the steeple of the church; 9 miles W.S.W. of Norwich. N. lat. $52^{\circ} 34'$. E. long. $1^{\circ} 7'$.

WINDHAM, a large post-township of Greene county, in New York, comprising all that part of the county on the S. and W. of the summit of the Catsbergs or Catskill mountains; bounded N. by Durham, Cairo and Catskill, E. by the northern angle of Ulster county, S. by Ulster and a part of Delaware counties, and W. by Delaware county. It has a post-office, and is about 24 miles in length, its medial breadth being about 12 miles.

It is mountainous, with much good pasture-lands that yield excellent dairy. It is watered by the Schoharie creek, which has several mill-seats and small branches. Along these streams are some alluvial lands, which are rich and fertile. The view from the Catsbergs, over which is a road, is very grand and interesting. The W. part of Windham is about 35 miles W. from Catskill, its principal market. The population consists of 3965 persons, and the senatorial electors are 267.

WINDHAM, a town of the state of Connecticut, on the Thames. It is the chief town of a county, to which it gives name. The county contains 28,611 inhabitants, and the town 2416; 63 miles S.W. of Boston. N. lat. $41^{\circ} 38'$. W. long. $72^{\circ} 11'$.—Also, a town of the state of Vermont, in the county of Windham, with 782 inhabitants; 20 miles E. of Bennington.—Also, a county in the S.E. part of the state of Vermont, bordering on the Massachusetts. It contains 26,760 inhabitants.—Also, a post-town of New Hampshire, in Rockingham county, with 743 inhabitants; 40 miles S.W. of Portsmouth.

WINDING, twisting from an even surface, or not a direct plane.

WINDING a Call, in *Sea Language*, denotes the act of blowing or piping upon a boatwain's whistle, so as to communicate the necessary orders of hoisting, heaving, belaying, slackening, &c. See CALL.

WINDING-Engine, in *Mining*, a machine employed to wind or draw up corves or buckets out of a deep pit or shaft. There are several different machines employed for this purpose, and each has a different name.

The most simple winding-machine is a roller placed horizontally over the pit, to wind up the rope, by which the bucket is suspended; the roller is turned round by a handle at each end. This simple machine, which is called a wind-lafs, wind-up, or roller, is commonly used for well-digging, and formerly was the common machine for mines; but for mining on the present system more powerful machinery is required. In Derbyshire it is called a slowse, and the construction is very minutely directed in the ancient mining-laws of the district, called 'The King's Field.' A small model or effigy of a slowse, constructed according to law, and fixed up "in sight of all men," is still the sign of legal possession of a lead-mine, and one of these must be constantly maintained at every thirty-nine yards in length of the vein of ore; for by those laws no man may work more than thirty-nine yards, and it is supposed that each one of these is a separate working and drawing up of the ore from the mine.

With this simple machine a man can work continually to draw up a weight of 3750 pounds, at the rate of one foot *per* minute, or any smaller weight with a proportionably quicker motion. This is a fair average of the strength of man, which has been determined by a number of experiments, as shewn in our article WATER. The radius of a winch or handle should not be above fourteen inches, which describes a circle of $7\frac{1}{2}$ feet circumference; a man can turn this round twenty times *per* minute with convenience, and the motion of his hands will therefore be $146\frac{1}{2}$ feet *per* minute, at which rate a man can exert a force of $25\frac{1}{2}$ pounds according to our standard. To apply a man's force to the greatest advantage, we must not depart much from these proportions; but the load which is drawn up at one time may be varied according to the diameter of the roller or barrel on which the rope winds: for instance, if this barrel is seven inches diameter, it will draw up the weight only one-fourth as fast as the man moves the handle; and in consequence the weight may be $4 \times 25\frac{1}{2} = 102$ pounds, and this he will be able to wind up at the rate of thirty-seven feet *per* minute. It is best to employ two men, and make the two handles at right angles to each other; the roller may then be 14 inches diameter, and they can draw up the 102 pounds at the rate of 74 feet *per* minute. The roller should have two ropes wrapped upon it in opposite directions, and a bucket being suspended from each, one bucket will be drawn up as the other is let down, and no time will be lost.

The next machine is the horse-gin: it has a large drum or barrel to wind up the rope; the barrel is mounted on a vertical axis, which is provided with one or more long levers, to the extreme ends of which a horse is harnessed, and by walking round in a circle, the barrel is turned round, and the rope which descends into the pit or shaft, is wound up by wrapping round the barrel. The gin is placed at a convenient distance from the mouth of the pit, and the rope is conducted over a pulley at the top of the pit, to change the direction from horizontal to vertical. The horse-gin usually has two ropes wrapping round the barrel in opposite directions, and one winds up as the other unwinds. The two buckets or corves which are suspended in the pit at the same time, go up and down alternately, one full and the other empty, and the weight of the empty corve, which is descending, tends in some measure to balance that which is coming up full.

The barrel must be turned in a contrary direction every time a basket is drawn up, and for this purpose the horse is turned

turned round every time, so as to draw the barrel round in one direction the first time, and in a reverse direction the next time. The horse turns at the same time that the baskets are unhooked and changed at the top and bottom of the pit, and very little time is lost. A boy is required to lead and direct the horse. In some large horse-machines wheel-work is introduced, to communicate the motion of the vertical axis of the horse-levers to the barrel on which the rope winds; and this work may be so contrived as to reverse the motion of the barrel at pleasure, although the horses always walk in the same direction.

In very deep pits an inconvenience is experienced from the weight of the great length of rope which must be employed; for the whole weight of this rope is added to the weight of the loaded corve when it is at the bottom of the pit; and at the same time, the other corve being at the top of the pit, there is no length of rope on that side to counterbalance. As the corve is drawn up from the bottom, the other descends into the pit; this shortens the length of the ascending rope, and increases the descending rope, so that by the time that the corve is half drawn up, the other is let half down, and the weight of the rope is equally divided, so as to be in balance; but after this, the descending rope becomes the longest, and its weight tends to weigh up the loaded corve, and in very deep pits, the weight of the rope exceeds that of the corve so as to draw it up: hence, there is a great inequality in the force required to turn the machine. To remedy this, the barrel is often made of a conical shape, being smallest in the middle, and larger towards the upper and lower ends; the ends of the two ropes are made fast to it in the middle, or at the smallest part, and therefore the horse has greater power when the corve is to be drawn from the bottom, and all the length of rope is added to its weight, because the rope winds on a smaller radius; but as the rope coils on the barrel, it winds on a larger part of the cone, and the power or leverage diminishes; therefore, the horse will draw up the corve with a rapidity which increases in proportion to the diminution of the load, by the shortening of the rope.

A very convenient mode of constructing a double conical barrel is to fix two circular wheels upon the axis, one for the top of the barrel, and the other for the bottom of the same. Two old cart-wheels are frequently employed for this purpose. The barrel on which the rope is wound is formed by a number of straight pieces of wood, which are fixed to the rims of the wheel, and extend from the upper to the lower one. These pieces are not fixed in a direction parallel to the vertical axis of the barrel, but are fixed crosswise in an oblique direction, and thus form a barrel, which is small in the middle, and larger at the ends. When a cylindrical drum is fixed upon the main shaft to wind up the rope, if the pit is deep, a counterbalance to the weight of the rope must be applied to a smaller conical drum fixed on the vertical axis above the great drum. The circumference of the conical barrel is grooved with a spiral groove, like the fusee of a watch; upon this fusee a rope is applied, which descends into a small pit made on purpose, and has a counter-weight at the end of it: this balances the unequal weight of the great rope, if the rapidity of the cone is properly proportioned. This answers very well for small depths; but for a deep pit, the fusee must be placed on a separate barrel. This barrel may be placed horizontally over the pit in which the balance-weight descends, and must have a wheel upon it to communicate by a rope with a wheel fixed upon the vertical axis of the gin; by this means, the same motion is communicated to a spiral, as if it was placed immediately on the vertical axis.

A perfect equal motion is not necessary for horse-work, and if it is not so much in extremes as to strain the horse in one part of his journey, whilst he has nothing to do in another, he will work very well. Gentle ascents and descents in a road are found as advantageous to the action of horses as a road upon a perfect flat. The following is the construction recommended by Mr. Smeaton for a two-horse gin for a lead-mine:—The horse-track 36 feet diameter, and two horses are employed at once; the diameter of the drum 14 feet; the weight to be drawn at once $5\frac{3}{4}$ cwt. or 644 lbs. exclusive of the bucket, because there are two, and the one serves as a balance for the other; depth of the pit 45 fathom, or 270 feet; the girth of the rope $6\frac{1}{2}$ inches. The counterbalance for the unequal weight of the great rope is constructed as follows:—Above the drum or rope-wheel, a smaller one, or balance-drum of one-fourth the diameter of the great drum, or 3 feet 6 inches, must be firmly fixed to the upright axis; also a little shaft or pit must be sunk at a convenient distance from the machine: if this is opposite the great pit, it will require less bracing to keep the fixed parts of the framing at their proper distances. A hole must be made in the circumference of the small wheel, or balance-drum, through which the end of a rope is passed, and secured by a knot. This rope, which is for the counter-weight, is to pass over a pulley of 3 feet or more diameter, such as is used to direct the great ropes down the main shaft; but it must be strongly and substantially fixed, because there will be a greater strain upon it. Over this pulley the balance-rope goes down into a little pit sunk for the purpose, and a balance-weight is hung to it, which must be double the weight of 45 fathom of the main pit-rope, and it will act as a counter-weight to the great pit-rope. The counter-weight must not, however, go down so as to touch the bottom of the little pit; and it must be so regulated as to be at the lowest point when the two buckets are at their meetings, half way down the main pit. Hence, whichever way the main drum turns round, the counter-weight will be drawn up, and will arrive at the top when either of the buckets arrive there: by this means, whatever be the weight of the rope, though it exceeds the weight of matter in the bucket, yet the horse will always have something to draw; whereas in the old horse-gins made at Newcastle, they had no other method than turning the horses at the point of equilibrium; and after that letting them draw the backward way, which obliged them also to walk backwards, till the bucket arrived at the top.

As a $6\frac{1}{2}$ -inch rope is far more than equivalent to the weight required to be drawn, the same sort of rope will do for the counter-weight also; but as there will be a great deal of chafing at the hole where it is fixed to the little drum-wheel, in consequence of its bending alternately one way and then the other, it will be proper to fortify it there with the white leather made of horses' skins, and the hole itself should be rounded off on each side, so as to make the rope bend easily.

In the sinking of the little shaft, if there is any particular advantage or obstacle, the depth may be greater or less than a quarter part of the main shaft; but then the size of the little drum and counter-weight must be proportioned accordingly. If practicable, the pit had better be deeper; and if it was half the depth, then the little drum might be half the diameter of the large one, and the counter-weight would be no more than the weight of the rope in the great pit. On account of the expence of the balance-pit, the double conical drum, which requires no counter-weight, is much preferable to any machine with a counter-weight.

In our article WATER we have given the experiments on the strength of horses; from which it appears that a proper load

WINDING-MACHINE.

load for a horse to work eight hours in a day is 22,000 lbs. avoirdupois, to be raised one foot in a minute, or any smaller weight to be drawn quicker in proportion; hence the weight of 644 lbs. may be drawn by two horses at the rate of 71 feet *per* minute, or the whole depth of 45 fathoms in $3\frac{3}{4}$ minutes. The horses will then walk in their circle rather more than three miles *per* hour; but $2\frac{1}{2}$ miles is the best pace. Horses are frequently loaded much more than this, and indeed one strong horse may work this machine; but as he could only work a short time each day, it is better to employ two.

When mines were sunk to very great depths, the drawing of the ore by horse-gins became too expensive, particularly for coal-mines, and more effective winding-machines were introduced. The water-gin was the first of these. The most simple of these is called a whimsey, and consists of a bucket, which is let down full of water, and by its descending force, draws up a loaded basket or corve from the bottom of the pit. (See WHIMSEY.) This machine requires a very considerable fall of water, and it can rarely be less than one-fourth or sixth of the whole depth from which the coal or ore is to be drawn.

In cases where the fall is smaller, an over-shot water-wheel is employed; and in order to make the wheel turn at pleasure either way round, so as to wind up or let down, the wheel is made double; that is, with two rows of buckets, one row adapted to receive the water from a spout, which will cause it to turn round in one direction, and the other row of buckets is supplied with water from a different spout, and will turn the wheel in the opposite direction. Each spout is provided with valves to stop the stream at pleasure, and when one is open the other must be shut, and thus the wheel may be made to turn either way round. This is a very old invention, and is fully described by Agricola in his *De Re Metallica*, 1621. It was at one time in very common use in the collieries, and they raised up the supply of water for it by a pump applied to the beam of the great steam-engine, or sometimes by an engine on purpose.

Mr. Smeaton made a machine, in 1774, for drawing coals at Griff, in Warwickshire, by a water-wheel, in which the motion of the wheel is always continued in the same direction; and by a change in the communication of the wheel-work, the barrel is made either to draw up or to let down.

In 1777 Mr. Smeaton made a larger machine for Long Benton colliery, at Newcastle, which is worked by the water raised by a steam-engine on Newcomen's principle. The water-wheel and machinery are represented in *Plate Winding-Engine*, in several different elevations. X is the over-shot water-wheel, which is 30 feet in diameter: it is mounted on a cast-iron axis, which is clearly represented in the drawing. The water is delivered upon the wheel by a spout from a trough or cistern, which is supplied by the pump of the steam-engine. This trough is supported on tall piers of masonry, one of which is shewn in the sketch. Upon the axis of the water-wheel are fixed two cog-wheels, U V, of 88 cogs each, and the cogs are turned towards each other; W is a trundle, which is situated between the two wheels, and is turned round by either of them, according as it is placed; but it is smaller in diameter than the space between the two wheels, so that it cannot engage with both wheels at the same time. The trundle is fixed at the extremity of a long shaft, as shewn in the plan, *fig. 1*; and the opposite end of this shaft is connected with the barrel on which the ropes are wound: this barrel is composed of two cones, joined together at their bases. The ropes from the barrel are conducted over pulleys at the top of the pit, as

shewn in the elevation, *fig. 2*, and descend into the same. The baskets, or corves, in which the coals are brought up, are hooked to the ends of the two ropes; so that by the motion of the water-wheel one basket is drawn up whilst another is let down.

To regulate the motion of the machine, two brakes or gripes are applied: one encompasses the great cog-wheel U, which is fixed on the axis of the water-wheel, in the same manner as the brake of a wind-mill; and in like manner, the fixed circle or brake is provided with a lever, as shewn in *fig. 4*, by means of which the brake can be drawn tight round the wheel, and will then cause such a friction as to stop the water-wheel and all the machine.

The other brake-wheel DC (*fig. 1*.) is fixed near the end of the long axis, and has clogs or pieces of wood applied at the top. This piece of wood is supported by a lever AB, as shewn in *fig. 2*, A being the centre; and to the other end, B, a box E is suspended, and contains as much weight as will press the clog upon the wheel, with the force necessary to retain the corve from descending when it is full loaded. To enable the man at the mouth of the pit to lower down the corve, a cord is fastened to the lever AB, and is conducted over the pulleys, *g k* and *l*, to the mouth of the pit, where it hangs down in a knot, which the man can always reach, and by pulling it, he raises up the lever, and releases the wheel from the clog. To prevent accidents, if the clog and lever A should fail to stop the machine, another clog and lever FG are applied beneath the wheel; this lever is drawn upwards by a cord and a block of pulleys O, which are attached to the lower part of the weight for the upper lever. This cord is conducted to the pit's mouth, and hangs down, so that the man can always reach it, and by pulling this, he compresses both the upper and lower clogs upon the wheel at the same time, which will be certain to stop it even if it be in a rapid motion; but he only resorts to this lower clog on occasion, as the curb-rein is used for a horse; the weight of the upper lever, like a horse's bridle, being a sufficient check for common use.

To make the machine wind either up or down, the trundle W must be changed from one of the wheels, U or V, to the opposite one, and this will cause the barrel to turn in an opposite direction. The pivot of the trundle W is supported by the long upright beam shewn in *fig. 3*, which is moveable on a centre at the lower end, so that by inclining it to the right or left, the trundle may be engaged with either of the wheels U or V. The requisite motion is given to the upright beam by two tackles of pulleys applied to the upper end of the beam, as shewn in *fig. 3*.

The ropes of both these tackles are fastened together, and hang down in a loop in reach of a boy, who can pull it either way, and make the trundle engage with either wheel, so as to wind up or let down the corves at pleasure. This boy is always stationed in a small room immediately over the wheels UV, so as to have the brake-lever, as well as the upright lever, always at his command; likewise the shuttle of the water-wheel, which is fixed, as is shewn in *fig. 3*. A lever is made to communicate with it, and from the opposite end of the lever a rod descends into the room, so that the boy, by pulling it, can open or shut the shuttle at pleasure. This he must do whenever the corve comes up, or rather before; and notice of the proper time is given by a large knot in the main rope. The water being then shut off, the wheel will continue to turn by its momentum until the corve comes fully up, but by that time will have diminished its velocity, so that the application of the brake will stop it without any strain: the man at the mouth of

the pit also applies the brake on the wheel C D. Immediately the motion ceases, the boy pulls the tackle, which disengages the trundle W from the wheel, but without engaging it with the opposite one, and in consequence the barrel is detached from the water-wheel. A man now seizes the corve with a long hook, like a shepherd's crook, and draws it aside; then another man releases the clog or brake on the wheel C D, and the wheel and the corve immediately descend upon the ground at the side of the pit. The pulley over the pit is raised up to a considerable height, because the machine cannot be stopped exactly at the precise spot; but if the corve should be drawn up a few feet higher than necessary, no harm can ensue as soon as the full corve is landed and exchanged for an empty one; and the same is done at the bottom of the pit. The boy throws the trundle in gear with the opposite wheel, then draws the shuttle to let the water flow upon the wheel, and the wheel resumes its motion.

For the facility of stopping the machine at the proper moment, Mr. Smeaton applied a piece of machinery, which he called a count-wheel. This received its motion from a pinion of 15 teeth, fixed upon the extremity of the pivot of the lantern W; the pinion gave motion to a small cog-wheel of 60 teeth, situated between the two great cog-wheels U V, being fixed at one end of an horizontal spindle; and at the opposite end of it was a pinion of eight teeth, which gave motion to the count-wheel. This wheel had 80 teeth, and was fixed in a vertical position. It had affixed to its plane two projecting pieces of iron, which operated upon a lever that was connected with the lever which lets down or draws up the shuttle to regulate the flow of water upon the wheel. These projections were so fixed to the wheel as to be capable of regulation in such manner, that when the machine had worked long enough to have brought up the corve to the top of the pit, the projection of the count-wheel would seize the lever, and let fall the shuttle so as to stop the water-wheel at the proper moment, without any attention on the part of the boy. This could be easily regulated by the position of the projection on the count-wheel, and when once adjusted always operated correctly; for as the count-wheel turned only once for forty turns of the barrel, the machine would therefore draw up a corve from the bottom of the pit before the count-wheel made a complete turn.

As the two corves in the pit ascend and descend mutually, they must pass each other at half the breadth of the pit; and it sometimes happens that they strike together, and overset the coals. The best remedy for this is to divide the pit in two, or make two separate pits, and the barrel may be situated between the two. As it is frequently impracticable to do so, a smaller projection was applied in Mr. Smeaton's machine upon the count-wheel, which acted in the middle of the course upon the lever, and raised it up so as to diminish the opening of the water-shuttle, and make the machine move slowly at the moment when the corves met and passed each other: this prevented accidents.

The principal dimensions of this machine were as follow:—The cylinder of the steam-engine 26 inches diameter, and 5 feet 8 inches the length of stroke. It made 14 strokes *per* minute. It was on the principle of Newcomen, *i. e.* atmospheric, with injection into the cylinder. The pump was 18½ inch bore, and 5 feet 8 inches stroke: it raised the water 33 feet high. This water, being conveyed in a trough to the machine, was delivered upon the water-wheel, which was 30 feet diameter, with 72 buckets; its cast-iron axis was 7 inches diameter; the great cog-wheels 12 feet diameter, with 88 cogs; the trundle 20 cogs, so that the barrel turned 4.4 times for once of the water-

wheel. The barrel was 5 feet 3 inches diameter in the middle, and 2 feet 11½ inches diameter at the ends; the whole length being 10½ feet. Upon the circumference of the barrel a spiral line is traced, and a groove sunk, which receives half of the rope, to prevent the rope from slipping on the barrel.

The depth of the pit was 165 yards; and it was found, on a long course of experiments, that the total consumption of coals was one corve of coals to draw up 82½ corves from that depth. The machine would draw 18 score of corves, each containing 20 pecks and weighing 5½ cwt., every 12 hours.

The more modern winding-engines by steam are upon a much more simple construction. The power of the steam-engine is applied at once to the barrel which winds up the rope, with only one pair of cog-wheels; *viz.* a large wheel fixed on the axis of the barrel, and a smaller one on the axis of the fly-wheel of the steam-engine. These engines are frequently made on Newcomen's principle, as the consumption of coals is a small object, but Mr. Watt's engines are more manageable. As the steam-engine with a crank will turn either way, according as it is let in motion, it is very well adapted for winding-machines; the boys who manage them are very dexterous in stopping and turning them the contrary way. See *STEAM-Engine*.

There are many ingenious contrivances for facilitating the landing of the corves when they come up to the pit's mouth. The best is a platform, which runs upon wheels, and can be pushed over the pit's mouth, when the corve is drawn up, by means of a light carriage with one horse, which is backed on the platform beneath the corve, and pushes the platform over the pit by the same motion. The corve is lowered down upon the carriage, and then the horse draws the corve away; the same motion withdraws the platform from the pit's mouth, ready to let down an empty corve and draw up another full one.

In many modern pits, conductors are fixed in the pit. These are perpendicular rods, and the baskets have projecting parts which embrace the conductors, and guide the corve regularly up or down the pit.

In many collieries flat ropes are used. These are composed of four small ropes placed flat, side by side, and sewed together by a packthread, which pierces all the four ropes. When these flat ropes are used, a barrel or drum of small size is used, and the coils of the rope wind one upon the other, so as to form a spiral, and increases the diameter of the effective barrel as the rope winds up, so as to balance the weight of the rope. This was invented by Mr. John Curr, of Sheffield, who has several patents for machinery for manufacturing such flat ropes, as they are extensively used in Yorkshire.

In others, iron chains are used instead of ropes, and are found to answer extremely well.

WINDING of Cotton. See *COTTON Manufacture*.

WINDING of Silk. See *Manufacture of SILK*.

WINDING-Screw Cheese-Press, in *Rural Economy*, a contrivance of this sort, in which the weight is laid, in the Gloucestershire Report on Agriculture, to be capable of being gradually let down on the vats. It is thus described:—A strong platform, or fill, is raised on four legs, about a foot from the floor; near the edge is made a channel all round, to carry off the whey as it is expressed, by a lip, into the pan or receiver. Two strong side-posts are mortised into the fill, reaching about six feet high; across which, about four feet high, is firmly fastened a strong bar, with an aperture in the centre large enough to let in the screw with ease. This screw is fixed, at the lower part, into a heavy cubical stone

of two feet dimensions, or nearly: the upper part of the screw, having passed the perforation in the cross-bar, enters a nut or female screw, large in the middle, but worked off at the two ends fine enough to be grasped by the hand: by turning this nut, the weight is raised or let down on the cheefe-vats underneath.

Where stones of the required weight and dimensions are not to be had, a wooden frame of the same size is used, which is filled with sand, pebbles, or rubble-stones.

The screw part of this press has, in many dairies, been lately superseded by the adoption of an apparatus less simple in its construction, though more easily worked. In which, on the right side of the press, a third upright is raised from the floor, and connected by two cross-bars, about a foot long, with the upright post parallel with it. About four feet high, a cylinder of wood, from five to six inches diameter, is inserted, passing quite through the additional upright, but kept to its place by a shoulder. To the end are fixed four spokes, or levers, or an iron handle, to which manual power is applied. A strong rope is fastened to and coiled round the cylinder, which passing over a pulley let lengthways into the upper bar, proceeds horizontally to another pulley, fixed directly over the centre of the weight, and by an iron hook attached to it. Very moderate strength will raise the weight, which in this construction slides with grooves fitted to the side-posts. The mechanical powers are varied in some presses by the use of a wheel of a foot or eighteen inches diameter, instead of the pulley; but the effect is similar. In either way of working the weight, there is a superiority over the old press, and little difference in the expence.

WINDING Stairs. See **STAIR.**

WINDING of Wool, in *Rural Economy*, the practice of putting it up into fleeces. There is some nicety required in this operation; all the loose ragged parts are to be turned inwards, so as to form a neat solid sort of fleece, and all the dirty parts removed. The work is done on a large table or bench for the purpose. In some cases of expert winders, four hundred fleeces can be wound in the course of the day.

WINDISCH FEISTRITZ, in *Geography*, a town of the duchy of Stiria, on the river Plufcka; 40 miles S. of Gratz. N. lat. 46° 30'. E. long. 15° 28'.

WINDISCH Gratz, a town of the duchy of Stiria; 18 miles N.N.W. of Cilley. N. lat. 16° 35'. E. long. 15°.

WINDISCH Landberg, a town of the duchy of Stiria; 12 miles E. of Cilley.

WINDISCH Mark, a part of Carniola, bordering on Hungary and Croatia.

WINDISCH Matray, a town of the archbishopric of Salzburg; 54 miles S.S.W. of Salzburg. N. lat. 46° 55'. E. long. 12° 36'.

WINDISH, a village of Switzerland, near Konigsfelden, at the conflux of the Aar and the Reufs, in the canton of Berne, in which are found the ruins of the ancient city of Vinodonissa, a fortress mentioned by Tacitus, which the Romans made a place of arms to stop the irruption of the Germans, and is said to have been the see of a bishop. It was destroyed in the 7th century; 3 miles W. of Baden.

WINDISHGARTEN, a town of Austria; 16 miles S.W. of Bavarian Waidhoven.

WINDLASS, or **WINDLACE,** a machine used for raising heavy weights, as guns, stones, anchors, &c.

It is very simple, consisting only of an axis, or roller, supported horizontally at the two ends by two pieces of wood and a pulley. The two pieces of wood meet at top; being placed diagonally, so as to prop each other. The axis, or roller, goes through the two pieces, and turns

in them. The pulley is fastened at top, where the pieces join.

Lastly, there are two staves, or handspikes, which go through the roller, by which it is turned; and the rope, which comes over the pulley, is wound off and on the same.

WINDLASS, an horizontal machine, composed of timber, &c. and most used in merchant-ships for heaving up their anchors in lieu of a capstan. The body of the windlass is octagonal, and is tapered from the middle to the ends by given dimensions. It is sawn from oak-timber of the best quality, and the length between the cheeks is in one piece. But when fitted with an iron axle or spindle in the middle, it must be in two pieces. The ends without the cheeks are fitted with iron spindles, and have a hoop driven over their ends. The spindles must be very accurately let into the ends and middle of the body, that the axis of each may exactly agree in a right line. A bolt is driven through the body of the windlass and each end of the spindles. On each end of the body is let on and securely bolted an iron pall-hoop, with teeth or notches at every two or three inches. The palls, which are iron, are fixed against the aft-sides of the pall-bits, and fall into the teeth or notches of the pall-hoop, so as to prevent it turning backwards when charged by the effort of the cable, &c. Holes or mortises are cut through, along the middle of the windlass on each square, to admit the handspikes, and each square of the body is covered with elm or fir facings between the cheeks, on the working side in particular. It is suspended by its axles or spindles in brass rhodings, or gudgeons, which are let in and bolted into a frame of oak-timber called the cheeks, which are let down through the deck, and bolted to the pall-bits.

There are other methods of fitting windlasses, but this is recommended as the best.

WINDLASS-Cheeks, pieces of oak or elm fastened to the sides of small vessels, and by which the ends of their windlasses are suspended.

WINDLE, in *Geography*, a township of England, in Lancashire; 10 miles N.E. of Liverpool.

WINDLESTRAW, in *Agriculture*, a term applied to the naked stems of the crested dog's-tail, and other natural grasses.

It is observed in the third volume of the Transactions of the Highland Society of Scotland, that the common *poa* there sometimes goes by the name of windlestraw-grass. See **GRASS,** and **POA.**

WINDMANNIA, in *Botany.* See **WEINMANNIA.**

WINDO, in *Geography*, a sea-port town of Sweden, in the province of Smaland; 85 miles N. of Calmar.

WINDORS, a town of the bishopric of Passau; 10 miles W. of Passau.

WINDOT CREEK, a river of America, which runs into the Ohio, N. lat. 37° 59'. W. long. 86° 48'.

WINDOW, *q. d.* **WIND-DOOR,** an aperture, or open place, in the side of a house, to let in the air and light.

Before glass windows came into use, (for the antiquity and first introduction of which, see **GLASS,**) the window casements were commonly made of a transparent stone, called *specularis lapis*, and thence called *specularia*; and before the *specularia*, veils were the only defence they had against the weather. Pitisc. Lex. Antiq. in voc. *Specularia*.

We have various kinds and forms of windows; as glass-windows, wire-windows, horn-windows, &c. Arched windows, circular windows, elliptical windows, square and flat windows, round windows, oval windows, Gothic windows, regular windows, rustic windows; to which add skylights.

The chief rules with regard to windows are, 1. That they be as few in number, and as moderate in dimensions, as may consist with other respects; inasmuch as all openings are weakenings.

2. That they be placed at a convenient distance from the angles, or corners of the building; because those parts ought not to be opened and enfeebled, whose office is to support and fasten all the rest of the building.

3. That care be taken the windows be all equal one with another, in their rank and order; so that those on the right-hand may answer to those on the left, and those above be right over those below; for this situation of windows will not only be handsome and uniform, but also, the void being upon the void, and the full upon the full, it will be a strengthening to the whole fabric.

As to their dimensions, care is to be used to give them neither more nor less light than is needful; therefore regard is to be had to the bigness of the rooms which are to receive the light. It is evident, that a great room needs more light, and, consequently, a greater window, than a little room; and *c contra*.

The apertures of windows, in middle-sized houses, may be four and a half or five feet between the jambs; and in the greater buildings, six and a half or seven feet; and their height may be double their length at the least. But in high rooms, or larger buildings, their height may be a third, a fourth, or half their breadth, more than double the length.

Such are the proportions for windows of the first story; and, according to these, must those in the upper story be for breadth; but, as to height, they must diminish; the second story may be one-third part lower than the first; and the third story, one-fourth part lower than the second.

WINDOWS, *Architrave*. See ARCHITRAVE.

WINDOWS, *Dormer*, or *Lutherns*. See LUTHERNS, &c.

WINDOWS, *Scenography of*. See SCENOGRAPHY.

WINDOWS, *Transom*. See TRANNSOM.

WINDOW and *House Tax*, is one of the assessed taxes transferred to the commissioners for the affairs of taxes. The duties charged annually with respect to the windows or lights in every dwelling-house, (for which, see TAX,) are subject to the following regulations.

All skylights, and all windows or lights, however constructed, in staircases, garrets, cellars, passages, and all other parts of dwelling-houses, to what use or purpose soever applied, and whether such windows or lights shall be in the exterior or interior parts of such dwelling-houses, to be charged to the said duties.

Every window or light in any kitchen, cellar, scullery, buttery, pantry, larder, washhouse, laundry, bakehouse, brewhouse, and lodging-room, belonging to or occupied with any dwelling-house, whether the same shall be within or contiguous to or disjoined from the body of such dwelling-house, shall be charged to the said duties.

The said duties to be charged yearly upon the occupier or occupiers of the houses, cottages, or tenements, in respect whereof the said duties shall be charged, and to be in force for one whole year, from the 5th day of April in the year in which the same shall be charged, to be levied on them, or on their respective executors or administrators, except as hereinafter provided.

Where any change in the occupation of any house, cottage, or tenement, shall take place after the assessment shall be made, then the said duties shall be levied upon and paid by the occupier, landlord, or owner, for the time being, or on both or all of them, according to their times or possession thereof, without any new assessment, notwithstanding

such change in the occupation for the year that such house shall have been assessed: provided, that where a tenant shall quit the same, on the determination of the lease or demise after an assessment made, and shall have given notice thereof to the assessor, the duty shall be discharged by the commissioners for this act for the remainder of that year, in case it shall appear to them at the end of such year, that such house, &c. shall have continued wholly unoccupied during the remainder of such year.

Where any dwelling-house is or shall be let in different apartments, tenements, lodgings, or landings, and shall be inhabited by two or more persons or families, the same shall nevertheless be charged as if inhabited by one person or family only; and the landlord or owner shall be deemed and taken to be the occupier, and shall be charged with the said duties: provided, that where the landlord shall not reside within the limits of the collector, or the same shall remain unpaid by him for twenty days after the same is due, the duties so charged may be levied on the occupier or occupiers respectively, and such payment shall be deducted and allowed out of the next payment on account of rent.

Every house, of which the keeping is left to the charge of any person or servant, shall be subject to the like duties as if it were inhabited by the owner or by a tenant; and, if such person or servant shall not pay rates to the church and poor, the said duties shall be paid by the respective owners or tenants of the said house.

Every distinct chamber or apartment in any of the inns of court, or of chancery, or in any college or hall in either of the universities of Oxford or Cambridge, or any public hospital, being severally occupied, shall be subject to the same duties as if an entire house, which shall be paid by the respective occupiers; provided, that every such chamber or apartment, which shall not contain more than seven windows or lights, shall be charged at the rate of 3s. 6d. for every such window or light.

All dwelling-rooms in any hall or office whatever, belonging to any person, or to any body politic or corporate, or to any company, lawfully charged with the payment of any other taxes or parish-rates, shall be subject to those hereby payable, and be respectively charged as dwelling-houses; and the person, &c. to whom the same shall belong shall be charged as the occupier or occupiers thereof.

When a partition or division between two or more windows or lights, fixed in one frame, is of the breadth or space of twelve inches, the window or light on each side of such partition or division shall be charged as a distinct window or light.

Every window extending so far as to give light into more rooms, landings, or stories than one, shall be reckoned and charged as so many separate windows as there are rooms, landings, or stories enlightened thereby.

Every window or light, including the frame, partitions, and divisions thereof, which by due admeasurement of the whole space on the aperture of the wall of the house or building, on the outside of such window or light, shall exceed in height twelve feet, or in breadth four feet nine inches, not being less than three feet six inches in height, shall be reckoned and charged as two windows or lights, except such windows or lights as shall have been made of greater dimensions at any time prior to April 5, 1785; except also the windows or lights in such parts of dwelling-houses as are used for shops, workshops, and warehouses, and except the windows or lights in the public room of any house licensed to sell wine, ale, or other liquors by retail, which shall be used for the entertainment of guests; and the windows or lights in farm-houses especially exempted from the duties

duties in the schedule marked (B.), or in any dwelling-house not chargeable to the duties mentioned in the said schedule.

Where any dwelling-house shall be divided into different tenements, being distinct properties, every such tenement shall be subject to the same duties as if the same were an entire house, which duties shall be paid by the respective occupiers; provided, that every such tenement, which shall not contain more than seven windows or lights, shall be charged at the rate of 3s. 6d. for every such window or light; and every such tenement in Scotland, which shall not contain more than seven windows or lights, shall be charged at the rate of 3s. for every such window or light.

The cases in which windows are exempted are the following.

1. Any house belonging to his majesty, or any of the royal family, and every public office, for which the duties heretofore payable have been paid by his majesty or out of the public revenue.

2. Any hospital, charity-school, or house provided for the reception and relief of poor persons, except such apartments therein as are or may be occupied by the officers or servants thereof, which shall severally be assessed, and be subject to the said duties as entire dwelling-houses.

3. The windows in any room of a dwelling-house, licensed according to law as a chapel for the purposes of divine worship, and used for no other purpose whatsoever.

Provided that every such hospital, charity-school, house for the reception and relief of poor persons, or room licensed as a chapel as aforesaid, shall be brought into charge by the assessor or assessors, or in their default, by the surveyor or inspector, and shall be stated on the certificate of assessments as such; and on due proof of the fact before the commissioners for executing the said act to discharge such hospital, &c. from the said duties, or such part thereof as is hereby intended to be exempted, in like manner as they are authorized to discharge the assessment on poor persons by this act, but not otherwise.

4. The windows or lights, in any dairy or cheese-room belonging to and occupied with any dwelling-house, chargeable with the said duties, although the same shall be part thereof, which shall be used by the occupiers for the purpose of keeping butter or cheese, being their own produce, for sale or private use; provided, that the windows or lights in such dairies or cheese-rooms shall be made with splines or wooden laths, or iron bars, or wires, and wholly without glass, and that the occupiers of the dwelling-houses to which such dairies and cheese-rooms belong shall cause to be painted on the outer door thereof, or on the outside of the windows thereof, or one of them, in large Roman letters, the words, "dairy, or cheese-room," as the case may require, and shall keep such words so painted distinctly legible, during all such time as such exemption shall be claimed; and provided, that such dairies or cheese-rooms shall not be ever used to dwell or to sleep in by any person, but shall be wholly kept for the several purposes hereinbefore mentioned; and provided also, that an assessment of all such windows or lights shall be duly made, and the fact be truly returned in the manner directed by this act, in other cases of exemption from the said duties, so that the number of windows so to be exempted may be ascertained, and the exemption be allowed by the commissioners for executing this act.

The provisions that respect the exemptions of windows from assessment by 43 Geo. III. c. 161. are as follow.

Windows are to be stopped up with stone or brick, or the same kind of materials as the outside of the house; allow-

ance being made for those in the roof made of the same materials with the outside of the roof, or stopped up before the commencement of this act; or windows are not to be made, reftored, or stopped up without six days' previous notice given to the surveyors, under a penalty of 10l.: and surveyors are to charge windows newly made or reftored, and omitted in the assessment; and the penalty on stopping up windows to elude payment is a charge on the occupier of the tenement, at the rate of double the sum by which the assessment shall be augmented, by reason of such certificate, subject to appeal, provided it be proved to the satisfaction of the commissioners for executing this act, that the same windows or lights were respectively stopped up according to the directions of this act, previous to the commencement of the year on which the said assessment shall or ought to have been made.

The duty on dwelling-houses (for which, see TAX) comprehends every coach-house, stable, brewhouse, washhouse, laundry, woodhouse, bakehouse, dairy, and all other offices, and all yards, courts, and curtilages, and gardens, and pleasure-grounds, belonging to and occupied with any dwelling-house, within the limits of one acre.

All shops and warehouses which are attached to the dwelling-house, or have any communication therewith, shall, in charging the said duties, be valued together with the dwelling-house and the household and other offices aforesaid thereunto belonging, (except such warehouses and buildings upon or near adjoining to wharfs which are occupied by persons who carry on the business of wharfingers, and who have dwelling-houses upon the said wharfs for the residence of themselves or servants employed upon the said wharfs.)

And also except such warehouses as are distinct and separate buildings, and not parts or parcels of such dwelling-houses, or the shops attached thereto, but employed solely for the purpose of lodging goods, wares, and merchandize, or for carrying on some manufacture (notwithstanding the same may adjoin to or have communication with the dwelling-house or shop.)

Every chamber or apartment in any of the inns of court, or of chancery, or in any college or hall in any of the universities of Great Britain, being severally occupied, shall be charged thereto as an entire house, and on the respective occupiers thereof.

Every hall or office whatever belonging to any person or to any body politic or corporate, or to any company lawfully charged with the payment of any other taxes or parish-rates, shall be subject to the duties as inhabited houses; and the person, &c. to whom the same shall belong shall be charged as occupier.

Where any house shall be let in different stories, tenements, lodgings, or landings, and shall be inhabited by two or more persons or families, the same shall nevertheless be charged to the said duties as if inhabited by one person or family only, and the landlord or owner shall be deemed the occupier, and shall be charged to the said duties: provided, that where the landlord shall not reside within the limits of the collector, or the same shall remain unpaid by such landlord for the space of twenty days after the same is due, the duties so charged may be levied on the occupier or occupiers respectively; and such payment shall be deducted and allowed out of the next payment on account of rent.

No dwelling-house, or other such premises as aforesaid, shall be estimated or rated at any less annual value than the rent or value at which the same premises stand charged in the last rate made on or before the time of making the assessment

assessment for the relief of the poor in the same parish or place, under certain specified restrictions with regard to the poor rate.

Where any dwelling-house shall be divided into different tenements being distinct properties, every such tenement shall be subject to the same duties as an entire house, which duty shall be paid by the occupiers respectively.

The cases of exemption are the following.

1. Any house belonging to his majesty, or any of the royal family, and every public office for which the duties heretofore payable have been paid by his majesty, or out of the public revenue.

2. Every dwelling-house, being a farm-house occupied by a tenant, and *bonâ fide* used for the purposes of husbandry only.

3. Every dwelling-house, being a farm-house occupied by the owner thereof, and *bonâ fide* used for the purposes of husbandry only, which, together with the household and other offices aforesaid, shall be valued under this act at 10*l. per annum*, or any less sum.

4. Any hospital, charity-school, or house provided for the reception or relief of poor persons.

5. Every house whereof the keeping is committed to the care of any person or servant, who doth not pay rates to the church and poor, and who resides therein for the purpose only of taking care thereof: provided, that an assessment shall be duly made in every such case, and the fact be truly returned in the manner directed by this act in other cases of exemption from the said duties, and the exemption be allowed by the commissioners for executing this act.

Any person inhabiting a dwelling-house, containing not more than six windows in the whole, shall be exempted from the duties in schedule (A.), in case such person shall be on the books of such parish or place as receiving parochial relief; and shall not be assessed, or liable to be assessed to any of the duties contained in schedules (B.), (C.), (D.), or (E.); which several exemptions shall be proved or claimed in the manner hereinafter mentioned.

And, in order to relieve such persons who may be charged to the several duties set forth in the schedules (A.) and (B.), or either of them, it is enacted, that where any such house, cottage, or tenement, as is described in the preceding clause, shall be brought into charge, and the occupier thereof shall be entitled to the said exemption by reason of poverty, in every such case, the assessors shall, on the certificate of assessment, set opposite the sum charged on the occupier thereof, the fact of his or her being poor, and shall return the same, together with the assessment and a certificate, as hereinafter mentioned, to the commissioners for executing this act in the district where such assessment shall be made; who, before allowing any such assessment, or making any order thereupon, shall examine the assessors, who shall respectively attend them for that purpose, at such time as they shall appoint, touching the return so made; and if the said commissioners shall, from such examination, and from the certificate hereinafter mentioned, be satisfied that any such occupier is entitled to such exemption, they may, after such proof, strike out the charge, leaving his name, and the number of windows and rent of such house in the assessment, and every such occupier shall be exempted accordingly; which exemption shall, in the like cases, extend to, and shall be allowed on all assessments on such poor persons, of the duties payable at the time of passing this act, which shall have been, or shall be made, at any time after the commencement of the present year.

But before any such exemption or abatement shall be allowed, the assessors shall produce to the commissioners a

certificate under the hands of five or more substantial householders of such parish or place, in vestry assembled, of whom the resident minister shall be one; but in case there shall be no such minister resident therein, then at least two or more churchwardens and overseers of the poor of such parish or place shall concur with such householders in such certificate, certifying thereby, that they have carefully examined the assessment of the said duties, and the allegations therein made by the assessors, touching such persons who shall be therein stated to be poor, and that in their judgment and belief the persons therein certified to be poor are entitled to be exempted by reason of their poverty, and are wholly unable to pay the duties assessed upon them; provided, that if in any parish or place there shall not be five substantial householders, then such certificate may be made by the substantial householders there residing; or if there shall be no churchwardens or overseers, then the same may be granted by the resident minister, or by any two churchwardens or overseers of any adjoining parish or place, who can certify the truth of such allegations, concurring therein with the substantial householders residing in the parish or place where such assessment shall be made.

And where the occupier of any house, cottage, or tenement, containing more than the number of windows or lights before specified, shall be brought into charge, and the occupier thereof shall, at the commencement of the year for which such assessment is made, be poor and indigent, or shall become so during that year, in every such case, such occupier may give notice thereof in writing, stating the causes to the assessor, or to the surveyor of the district in which such house is situate, annexing thereto a certificate, under the hands of such persons as aforesaid, certifying that, in their judgment and belief, such person is justly entitled to relief on account of poverty for the causes mentioned in such notice; and every assessor shall deliver the notices by him received to such surveyor: and if such surveyor shall be satisfied of the truth thereof, after due examination of the facts and circumstances, and that such person is unable to pay the duties charged on him or her, and has no probable means of bettering his or her condition within that year, he is hereby required to certify the same to the commissioners; and if such surveyor shall not be satisfied, then, on notice thereof to such occupier, he may appeal from such charge to the commissioners, giving ten days' previous notice thereof to the said surveyor.

And in every case where the surveyor shall certify to the said commissioners that he is satisfied of the truth of the claim made by any such occupier, and that he is, and will be unable to pay the duties charged on him or her within that year; or if, upon appeal, it shall appear to the satisfaction of the major part of the said commissioners present, on the oath of such appellant, or by other lawful evidence on oath produced by such appellant, that he or she is entitled to maintain such appeal, and wholly unable to pay the duties charged on him or her, the said commissioners may give such relief, either by striking off the whole of the duty so charged, or diminishing the same, as to them shall seem meet and necessary; and which appeals, for the causes in this clause mentioned, may be heard and determined, either on the days mentioned in this act for hearing appeals in other cases, or at the end of the year, or any days to be appointed by the respective commissioners for executing this act; which exemption shall, in the like cases, extend to, and shall be allowed on all assessments on such poor persons of the duties payable at the time of passing this act, which shall have been or shall be made at any time after the commencement of the present year.

Unoccupied houses are to be inferted in the affeffment, and the affeffors, or the furveyors and infpectors, are to certify when they become occupied; and the perfon occupying fhall give notice to the affeffor, furveyor, or infpector, within twenty days after occupation, under a penalty of 5*l.*, and be liable to be charged for the ref of the preceding quarter; and houfes becoming unoccupied after affeffment are to be charged for the whole year, unlefs notice is given. Notices are alfo to be given by occupiers of houfes or managers of hofpitals, charity-fchools, poor-houfes, or licenfed chapels, entitled to exemptions; and the exemptions are to be allowed by the commiffioners after examination. Burn's Juftice, vol. v. See TAX and COMMUTATION.

WINDOW, in *Anatomy*, &c. See FENESTRA.

WINDRUSH, in *Geography*, a river of England, in the county of Oxford, which runs into the Thames, 5 miles S.S.W. of Witney.

WINDSBACH, a town and citadel of Germany, in the principality of Anfpach; 10 miles S.E. of Anfpach. N. lat. 49° 13'. E. long. 10° 46'.

WINDSHEIM, a town of Bavaria. The inhabitants are chiefly Lutherans. This town was imperial till 1802, when it was given to the elector of Bavaria; 28 miles S.W. of Wurzburg. N. lat. 49° 34'. E. long. 10° 26'.

WINDSOR, commonly called NEW WINDSOR, to diftinguifh it from a parifh named Old Windfor, a market and borough town of Berkfhire, England, is eminent in the hiftoric annals of the kingdom, on account of containing one of the palaces of the fovereigns, and from the many diftinguifhed events which are identified with the place. Some of our moft eminent military and chivalrous fovereigns have made the caftle, or palace of Windfor, their chief refidence, and confequently the fcene of various celebrated feftivities, tournaments, and national affemblies. In the annals of the caftle, this is fully verified. When the Domefday-book was compiled, the caftle, which had been then lately built by William the Conqueror, was within the manor, and it is probable within the parifh of Clewer, of which Windfor was formerly a chapelry: it afterwards became the feat of an extenfive honor.

We are told by the Saxon Chronicle, that William the Conqueror kept his Whitfuntide at Windfor in 1071; and that a fynod was held there in 1072, wherein the province of York was made fubject to Canterbury. It is probable, that William Rufus kept his Whitfuntide at Windfor in 1095, his Christmas in 1096, and his Eafter in 1097: but in all probability all thefe feftivals were held at the palace at Old Windfor. Windfor-caftle feems to have been intended by William the Conqueror more for a military poft, for which by its fituation it was well adapted, than for the refidence of himfelf and his fucceffors.

Several monarchs kept their Christmas and other feftivals at Windfor; on fome of which occafions there were tournaments and other chivalrous fêtes performed. After the contentions between Stephen and Maud, Windfor-caftle, as the fecond fortrefs of the kingdom, was committed to the cuftody of Richard de Lacy.

It appears that a new barbican, or out-work, was built to the caftle by king Henry III. In 1263, during the wars between that monarch and his barons, prince Edward garrifoned Windfor-caftle with foreigners, who nearly deftroyed the town, and did much injury to the furrrounding country. The fame year it was given up to the barons, and the king made an order that Eleanor, wife of prince Edward, with her daughter and all her houfehold, fhould, without delay, retire from the caftle.

A great tournament was held in Windfor-park on the 9th of July, in the fixth of king Edward I. That monarch and his fucceffor, king Edward II., refided frequently at Windfor, where feveral of their children were born.

John, king of France, and his fon Philip, were prifoners in Windfor-caftle. David, king of Scotland, is alfo faid to have been prifoner there at the fame time.

All hiftorians agree, that Windfor-caftle owes its magnificent fabric to the affection which king Edward III. bore to the place of his nativity. Walfingham relates, that in 1334, he built a chamber, which he called the round table, 200 feet in diameter: this, by other accounts, appears to have been only a temporary ftructure. Holinghed fays, that in 1359, "the king fet workmen in hand, to take down much old buildings belonging to the caftle of Windfor, and caufed divers other fair and fumptuous works to be fet up in and about the fame caftle, fo that almoft all the mafons and carpenters, that were of any account within the land, were fet for, and employed on the fame works." But it appears that various commiffions for appointing furveyors and imprefing workmen had been iffued fome years before; and that in 1356, William of Wykeham, then one of the king's chaplains, was made clerk of the works with ample powers, and a fee of one fhilling a day whilft at Windfor, and two fhillings when he went elfewhere upon bufinefs: his clerk had a falary of three fhillings a week. In 1359, the architect's powers were further enlarged, and he was appointed keeper of the manors of Old and New Windfor. The next year 360 workmen were imprefed to be employed on the buildings at the king's wages, fome of whom having clandestinely left Windfor, and engaged in other employments for greater wages, writs were iffued to prevent perfons employing them, on pain of forfeiting all their goods and chattels, and to commit fuch of the workmen as fhould be apprehended to Newgate. The plague having carried off a great number of the king's workmen in 1362, new writs were iffued to the fheriffs of feveral counties to imprefs 302 mafons and diggers of ftone to be employed in the king's works. The counties of York, Salop, and Devon, were to furnifh fixty men each. Glaziers were imprefed in the year 1363; very few commiffions were iffued after the year 1369, and none after 1373, fo that it may be prefumed that this noble work was then completed; comprifing the king's palace, the great hall of St. George, the lodgings on the eaft and fouth fides of the upper ward, the round tower, the chapel of St. George, the canon's houfes in the lower ward, and the whole circumference of the walls, with the towers and gates.

The appeal of high treafon, brought by the duke of Lancafter againft Thomas Mowbray, duke of Norfolk, in 1398, was heard by king Richard II., on a fcaffold erected within the caftle at Windfor, when, it being found impoffible to reconcile the opponents, a day of combat was appointed to take place at Coventry. The caftle continued to be the occafional refidence of our monarchs, who from time to time made various alterations in the buildings, particularly king Henry VII. Windfor-caftle was garrifoned by the parliament, foon after the breaking out of the civil war between Charles and his fubjects; and colonel Venn, who was afterwards one of the king's judges, was appointed the governor. Prince Rupert made an unfucceffful attack upon it in the autumn of 1642. The caftle continued under the jurifdiction of parliament during the war, and in the year 1648 became the prifon of its unfortunate monarch. Judge Jenkyns was alfo a prifoner here for feveral years; whence he was removed to Wallingford, in 1656.

Upon the Reftoration, king Charles II. finding the build-
ings

ings of the castle much dilapidated by plunder and neglect, caused it to be thoroughly repaired and richly furnished. During the greater part of his reign, he made Windsor his summer residence. King James II. in 1687 received the pope's nuncio at Windsor-castle. Queen Anne, when princess of Denmark, lived in a small house adjoining the little park, and was very partial to Windsor.

During the reign of his present majesty, Windsor-castle has undergone considerable improvements, under the direction of the late James Wyatt, esq. surveyor-general of his majesty's works.

The castle consists of two courts, between which is the keep, or round tower. The upper court contains on the north side the state apartments, chapel, and the hall of St. George. The east and south sides have been lately fitted up for the residence of their majesties and the royal family. Our limits will not allow us to enter into a detail of the magnificent rooms which constitute the state apartments, or of dwelling on the valuable collection of pictures therein contained.

St. George's hall, on the north side of the upper ward, was built by king Edward III., as a refectory for the knights companions of the garter: it is a noble room 108 feet in length. The ceiling and walls are painted by Verrio; the subjects are the triumphs of the warlike founder, and his brave son, Edward the Black Prince.

In the area of the upper court is a bronze statue of king Charles II. on horseback, executed by Stada at the expence of the munificent Tobias Rustat.

On the north side of the castle is the terrace made by queen Elizabeth, which was extended by king Charles II. along the east and south sides: its whole length is 1870 feet, and it may be regarded as the noblest walk of the kind in Europe, as well as the most interesting in situation.

The chapel of St. George is situated on the north side of the lower court of the castle. King Henry I. built a chapel at Windsor, dedicated to St. Edward the Confessor, and placed in it eighty canons, who were maintained out of the king's exchequer. This chapel appears to have been rebuilt, or considerably enlarged and decorated, by king Henry III.: that monarch, in the year 1243, issued a commission to Walter de Gray, archbishop of York, to expedite the works at the king's chapel at Windsor, directing that the workmen should proceed as well in winter as in summer, till the whole was completed; that a lofty wooden roof, like the roof of the new work at Lichfield, should be made to appear like stone-work, with good ceiling and painting: that the chapel should be covered with lead, and four gilded images be put up in it, where the king had before directed images of the same kind to be placed; and that a stone turret should be made in front of the chapel of sufficient size to hold three or four bells. Some remains of Henry III.'s buildings, as may be presumed by the style of the arches and architectural decorations, may be seen on the south side of the dean's cloisters, and at the east end of the chapel behind the altar.

King Edward III., who had been baptized at Windsor, rebuilt St. Edward's chapel there, and dedicated the new structure to the Virgin Mary and St. George. In the year 1349, he augmented the number of canons to twenty-three, besides a warden; and appointed 24 poor knights, for all of whom he built habitations, and granted land for their support. In 1351, the bishop of Winchester made considerable alterations in the college; and Henry IV. changed the title of warden to that of dean.

The present splendid and truly interesting chapel of St. George may be regarded as the most perfect and most

beautiful pile of ecclesiastical architecture in the kingdom. It was commenced by king Edward IV. and committed to the superintendance of Richard Beauchamp, bishop of Salisbury. The work was not completed till the reign of king Henry VIII.: the beautiful roof of the choir was put up in the year 1508. Sir Reginald Bray, prime minister to king Henry VII., and one of the knights companions of the order of the garter, who died in 1502, succeeded bishop Beauchamp in the superintendance of this great work, and was a liberal contributor to the building of the choir and other parts of the fabric: his cognizance is frequently repeated on the roof of the choir, as are the royal arms and those of several noble families with the order of the garter. The rood loft and lanthorn were erected in 1516; the present organ-gallery and screen at the end of the choir are of Coade's artificial stone. The stalls of the knights companions, which are very richly carved in wood, exhibit the names and arms of the several illustrious and noble persons by whom they have been respectively filled. The altar-piece, which represents the Last Supper, is by Mr. West, from whose designs the east window, representing the Resurrection of our Saviour, was executed in painted glass by Jarvis and Forest, and put up in 1788: the expence of the latter was about 4000*l*. Another window by the same artists display the angels appearing to our Saviour. Most of these improvements, as well as several others in the chapel and castle, have been executed under the patronage, and partly at the expence, of his present majesty. Beneath the choir repose the remains of Henry VIII., his queen, lady Seymour, and king Charles I. Henry VI. was also interred in this chapel; also his rival and successor, Edward VI.

At the east end of the south aisle is the Lincoln chapel, which contains the monument of Edward, earl of Lincoln, lord high admiral of England for thirty years, who died in 1584. Sir Henry Clinton, bart., a descendant of the earl of Lincoln, was buried in this chapel in 1795. In the same aisle is an elegant chantry chapel, built by John Oxenbridge, canon of Windsor. Farther west is a chapel built by Dr. Oliver King, bishop of Bath and Wells, who died in 1492.

In the middle of the south aisle is a spacious chapel, founded by sir Reginald Bray, who died in 1502, and is here interred: his arms and crest appear in several parts of the chapel, particularly in the beautiful screen which separates it from the aisle.

At the west end of the south aisle is the Beaufort chapel, in which is an altar-tomb with the effigies of the founder, Charles Somerfet, earl of Worcester, who died in 1526, and his lady; and a splendid monument, supported by Corinthian pillars, to the memory of Henry, the first duke of Beaufort, who died in 1699.

Near the south door of the choir is interred Charles, duke of Suffolk, a favourite minister and brother-in-law of king Henry VIII., who died in 1545.

On the west side of the choir-door in the north aisle is a chapel built by Elizabeth, wife of William, lord Hastings, who is buried here.

At the east end of the chapel is a distinct though attached building, called the tomb-house, which was commenced by Henry VII. and intended for his burial place. It was granted by Henry VIII. to cardinal Wolsey, who began a sumptuous monument for himself within its walls. This was destroyed in the civil wars. James II. fitted up the building as a Roman Catholic chapel; and publicly attended the celebration of mass. After that monarch's decease the chapel was deserted; but in 1800 his present majesty gave orders

orders for it to be repaired, beautified, and appropriated for the interment of his family. The princess Mary and the princess Charlotte of Wales have been committed to its vault. On the north and east sides of the chapel are houses and lodgings for the dean and canons. The south and west sides of the lower ward are occupied by houses appropriated to the poor knights.

Between the two wards or courts of the castle is the keep, or round tower, for the residence of the governor of the castle. It consists of a lofty, artificial, conical mount, surrounded by a moat, and surmounted by a strong fortified tower, which is approached by a flight of 100 steps. The circumference of the whole castle is 4180 feet; its length from east to west 1480 feet; and the area, exclusive of terrace walks, is about twelve acres.

On the south side of the castle is a modern mansion, called the Queen's-lodge, where the royal family resided for several years; but it is now unoccupied. About half a mile S.E. of the castle is Frogmore, a modern seat belonging to the queen. It is principally noted for its beautiful garden.

To the south and west of the town is *Windfor Forest*, which formerly was computed to measure 120 miles in circuit. At present it is about 56 miles. A part of this, called the great park, consists of 3800 acres. The little park, on the north and east sides of the castle, contains about 500 acres.

Windfor is a large irregular town, disposed on the sides of a hill, and at its base, on the southern banks of the Thames. In 1276 it was declared a free borough by king Edward I., who granted to the burghesses a mercatorial guild, and various privileges and exemptions. He constituted it the county-town. King Edward IV. incorporated the burghesses by the name of mayor, bailiffs, and burghesses. By the last charter of king Charles II., the corporate body is made to consist of twenty-eight or thirty members. A weekly market is held by royal grant, as well as three annual fairs. Near the centre of the town is a guildhall or town-house, which was built in 1666.

This borough sent two members to parliament in the reign of Edward I.; but omitted making any returns from 1340 to 1446. The right of election has frequently been contested, but was finally settled to be vested in all the inhabitant householders not receiving alms. Windfor has continued to increase in population for the last 300 years. In 1555, there appears to have been 1000 persons; in 1801, they amounted to 3461; and in 1811 to 6155, who occupied 1051 houses. The parish-church is a spacious building, and part of it ancient, though it was formerly only a chapel subordinate to the church of Clewer. In it are several old monuments. On the west side of the town are extensive barracks, and an hospital for sick soldiers.

WINDSOR, *Old*, a village about two miles S.E. of New Windfor, was a place of some consequence at the time of the Domeſday-survey, as by that record it is stated to contain 95 houses, which paid gabel tax to the crown. Some of the Saxon kings had a palace here, and Edward the Confessor sometimes kept his court at this place. After William the Conqueror had erected a castle at New Windfor, the old palace and the surrounding houses were gradually deserted. A great part of Windfor-park is within the parish of Old Windfor, and includes three lodges: 1. The great lodge built in the reign of Charles I. and occupied by the illustrious William, duke of Cumberland; 2. The little lodge or dairy, occupied by the deputy ranger; and 3. The nanor lodge near Virginia water. Beaumont lodge, the seat of lord viscount Ashbrooke, was originally built by lord Weymouth, who died in 1705. There are other fa-

mily mansions and villas in this parish; one of which was lately fitted up and occasionally occupied by the princess Elizabeth, now princess Homberg.—The Magna Britannia, by S. Lysons and the Rev. D. Lysons, Berkshire, 4to. 1806. The Beauties of England, &c. vol. i. by J. Britton, F.S.A. and E. W. Brayley, 8vo. 1801. The History of Windfor and its Neighbourhood, by J. Hake-will, Architect, 4to. 1813. This elegant volume contains accounts and views of several places in the vicinity of Windfor. The History of the Royal Residences, 4to. 1817, by J. Pyne, a very handsome and interesting work, contains several views of the state apartments in Windfor-castle. The Architectural Antiquities of Great Britain, 4 vols. 4to. by J. Britton, contains several views, and a full history and description of St. George's chapel.

WINDSOR, a large township in the south-east corner of Broome county, New York, erected in 1807 from the east part of Chenango; situated 15 miles E. of Chenango; bounded north by Chenango county, east by Delaware county, south by the state of Pennsylvania, and west by Chenango. Its extent is nearly 15 miles square, and it has two post-offices. It is traversed by the Susquehanna river. In 1810 it had eleven saw-mills, seven grain-mills, a fulling-mill, and carding-machine, eight school-houses, one house of worship, a population of 1960 souls, 138 electors, and nearly 300 families.

WINDSOR, a town of Nova Scotia; 25 miles N.W. of Halifax.—Also, a town of the state of Vermont, capital of a county of the same name, which contains 34,877 inhabitants; the town contains 2757 inhabitants; 92 miles N.W. of Boston. N. lat. 43° 33'. W. long. 72° 22'.—Also, a town of the state of Connecticut, on the west side of the Connecticut river, in the county of Hartford, with 2868 inhabitants; 3 miles N. of Hartford.—Also, a town of Massachusetts, in the county of Berkshire, with 1108 inhabitants; 136 miles W. of Boston.—Also, a township of Pennsylvania, in Berks county, with 1358 inhabitants; 70 miles W. of Philadelphia.—Also, a township of Pennsylvania, in York county, with 1739 inhabitants.—Also, a town of New Hampshire, in the county of Hillsborough, with 238 inhabitants.—Also, a town of North Carolina; 23 miles S.W. of Edenton.—Also, a township of Lower Canada, on the St. Francis.

WINDSOR, *East*, a town of New Jersey, in Middlesex county, with 1747 inhabitants.—Also, a town of the United States of America, in Connecticut, on the east side of the Connecticut, opposite Windfor, with 3081 inhabitants.

WINDSOR, *West*, a town of New Jersey, in Middlesex county, with 1714 inhabitants.

WINDSOR, *New*, a post-township of Orange county, New York, on the west bank of the Hudson; 100 miles S. of Albany; bounded north by Montgomery and Newburgh, east by the Hudson, south by Cornwall and Blooming-grove, west by Montgomery and Walkkill. Its medial extent east and west is eight miles, and north near four, giving an area of about 30 square miles. Its population in 1810 consisted of 2331 persons, and its senatorial electors were 147. It has two post-offices, viz. the village of New Windfor, pleasantly situated on the west bank of the Hudson, and having considerable trade; and Little Britain, said to be discontinued in 1813. This township has several mill-streams, and the land is occupied chiefly by farmers, who enjoy much of the independence resulting from prosperous industry. The whole is well watered by springs and brooks.

WINDSOR *Forest*. See WINDSOR.

WINDSOR *River*, a river of the state of Connecticut, which runs into the Connecticut, 4 miles N. of Hartford.

WINDSOR *Bean*, in *Agriculture and Gardening*. See BEAN, and VICIA.

WINDTBERG, in *Geography*, a town of the duchy of Holstein; 4 miles S.S.E. of Meldorp.

WINDTHAAG, or WINDTHAG, a town of Austria; 3 miles E. of Bavarian Waidhoven.

WINDWARD PASSAGE, a name given to a course from the south-east angle of the island of Jamaica, in the West Indies, and extending from 160 leagues to the north side of Crooked island, in the Bahamas. Ships have often sailed through this channel, from the north part of it to the island of Cuba, or the gulf of Mexico, notwithstanding the common opinion, on account of the current which is against it, that they keep the Bahama shore on board, and that they meet with the wind in summer for the most part of the channel easterly, which, with a counter current on shore, pushes them easily through it.

WINDWARD *Islands*, in opposition to Leeward. These islands in the West Indies extend from Martinico to Tobago. See WEST INDIES.

WINDWARD *Point*, a cape on the north-east coast of the island of St. Christopher. N. lat. 17° 23'. W. long. 62° 22'.

WINDY TUMOURS. See TUMOUR.

WINE, the fermented juice of the grape. The name is also applied to the fermented juice of other subacid fruits.

It is impossible to fix the era when mankind first discovered fermented liquors. Some historians have ascribed the discovery to Noah, others to Saturn, others to Bacchus, &c. In short, almost every country in which the vine is indigenous has boasted of some individual or native deity, to whom the honour has been attributed; and if we reflect upon the simplicity of the processes essentially necessary to be had recourse to in making wine, it will appear exceedingly probable that the discovery was not made by one person or country exclusively, but by different individuals and nations at very different periods. A poet has elegantly represented wine as a recompence given by the deity for the miseries brought upon mankind by the general deluge:

“ ——— Deus nobis felicia vini
Dona dedit, tristes hominum quo munere fovit,
Reliquias; mundi solatus vite ruinam.”
Prædium Rusticum.

Different kinds of wine were known at a very early period; and as civilization and luxury advanced, the number was greatly extended. Hence the cultivation of the vine became an object of importance, and many new varieties were produced, which, favoured by soil and situation, rendered particular places more famous than others. Thus the ancient Romans not only possessed a great variety of native wines, but, in the days of their greatest splendour, those also of distant and still more favoured climes, as the *Vinum Chium*, *Lesbium*, *Leucadium*, *Rhodium*, &c. &c. See Pliny, xiv. 6.

Little is known respecting the modes of manufacturing some of the most celebrated of the ancient wines. The general processes, however, did not perhaps differ much from those at present in use. The fruit was collected, bruised by the feet, and subjected to pressure, as now practised. The juice that first flowed spontaneously was called *πρωτοπον* by the Greeks, and by the Romans *vinum primarium*; such as was obtained by pressure was denominated *δευτεριον*, or *vinum secundarium*, and considered as inferior.

Both Greeks and Romans appear to have frequently concentrated their wines, either by spontaneous evaporation, or by boiling. For the former purpose, the wine was sometimes introduced into bladders or large jars, and exposed in

the chimney to the heat of the fire, or in the upper parts of the house to the heat of the sun. Sometimes the fruit was converted into raisins by drying, and the wine prepared from such fruit was denominated *passum*. At other times the *must* was reduced by boiling to one-half. This formed the *vinum defrutum*: occasionally even to one-third, when it was termed *Sapa*. (See Pliny, xiv. 9.) By one or perhaps more of these methods, the wines were reduced to the state of syrup, or in some instances even to dryness, and were capable of being preserved for a very long time. Thus Aristotle states, that the Arcadian wines required to be diluted with water before they were drunk, as indeed was the case with most of the ancient wines; and Pliny speaks of wines as thick as honey, which it was necessary to dissolve in warm water, and filter through linen, before they were used. This was the case with the wine of Cæcuba, according to Martial:

“Turbida folicito transmittere Cæcuba facco.”

Pliny mentions Staphylus as the first who mixed wine with water; but Athenæus gives the credit of it to Amphitryon, king of Athens. On this occasion a fable was invented, that Bacchus, having been struck by a thunderbolt, and being all inflamed, was presently cast into the nymphs' bath, to be extinguished.

These remarks, however, are applied by the above authors chiefly to very old wines. Thus the wine compared by Pliny to honey had been made two hundred years before, in the time of consul Opimius: indeed wines of a hundred years old, and upwards, seem not to have been uncommon among the luxurious citizens of ancient Rome. (See Hor. od. iii. 14. 18. Juvenal, v. 34.) And similar allusions will be found in various other authors. Seven years was the shortest period, according to Aristotle and Galen, for keeping a wine before it was fit for drinking.

Among the Romans, the age of wines was, as it were, the criterion of their goodness. Horace, in his odes, which one may call *Bacchic songs*, boasts of his drinking Falernian wine, born, as it were, with him, or which reckoned its age from the same consuls.

The age of wine has been reckoned by leaves: thus they say, wine of two, four, or six leaves, to signify a wine that was two, four, or six years old; taking each new leaf put forth by the vine, since the wine was made, for a year. The moderns keep no wine to such an age as that mentioned by Pliny. Where they are kept the longest, as in Italy and Germany, there are scarce any to be found of above fifteen leaves. In France, the wines that keep best, as those of Dijon, Nantz, and Orleans, are reckoned superannuated at five or six years old.

Wine kept in a cool vault, and well secured from the external air, will preserve its texture entire in all the constituent parts, and sufficiently strong for many years, as appears not only from old wines, but other foreign fermented liquors, particularly those of China, prepared from a decoction of rice, which being well closed down in the vessel, and buried deep under ground, will continue, for a long series of years, rich, generous, and good, as the histories of that country universally agree in assuring us.

Sir Edward Barry, in his Observations, historical, critical, and medical, on the Wines of the Ancients, suggests, that our best modern wines, especially those of a delicate texture and flavour, may be more effectually preserved in earthen vessels of a larger size than our bottles, well glazed externally and internally: that dry sand is preferable for covering the bottles in the bins to saw-dust; and that a small

WINE.

small anti-cellar, built before all large cellars, would be a considerable defence and improvement.

The ancients were fond of giving their wines an artificial flavour, and for this purpose they introduced pitch, turpentine, and different herbs into the *must*; a practice still followed by the modern Greeks. Plin. *ubi supra*.

Such are the principal facts known respecting the celebrated ancient wines, which, as Chaptal justly remarks, appear in general to have rather deserved the name of *extracts* or *syrops* than wines. They must have been sweet and little fermented, and consequently have contained a very small proportion of alcohol. Indeed it is difficult to suppose how they could contain any spirit whatever, or possess in consequence any intoxicating properties.

The above remarks, however, can be only applicable to those wines which the refinements of luxury or caprice had rendered valuable, from their uncommon occurrence, or the difficulty with which they were procured. It is certain that the ancients were well acquainted with the fermentative process, and ordinarily took advantage of it in the formation of their wines: hence it is extremely probable that the wines used in the primitive states of society, and perhaps at all times by the common people, consisted simply of the fermented juice of the grape, and therefore differed in no respects whatever from the wines in common use at the present time.

General Principles of Wine-making.—We shall consider this interesting subject under two principal points of view: 1st, The manufacture of wine from grapes; and 2d, From other fruits.

1. The manufacturing of wine from grapes is liable to be influenced by a great variety of circumstances, such as *climate, soil, aspect, season, &c.*; of some of the most important of which we shall take a cursory view.

The vine is a native of the middle regions of the temperate zone, that is to say, between the latitudes of 25° and 50°, and here only does it flourish and mature its fruit in absolute perfection. Indeed a belt comprised between the latitudes of 40° and 50°, may be said to include all the most celebrated vineyards of the northern hemisphere; those, namely, of Spain, Portugal, France, Italy, Austria, Styria, Carinthia, Hungary, Transylvania, and part of Greece. The vine grows beyond the latitude of 50°, but its juices are auster, and without the requisite degree of saccharine matter to form good wine. The fine aromatic odour and flavour of its fruit also are not developed much beyond this latitude. In the southern hemisphere, which is colder than the northern, the vine flourishes somewhat nearer the equator.

The vine grows in every soil, but that which is light and gravelly is best adapted for its cultivation. It flourishes extremely well also in volcanic countries. Thus some of the best wines in Italy are made in the neighbourhood of Vesuvius. The famous Tokay wine is also made in a volcanic district, as are several of the best French wines; many parts of the south of France bearing evident marks of extinct volcanoes. The vine also flourishes well in primitive countries, and especially among the debris of granite rocks: thus the celebrated Hermitage wine is made from a soil of this description.

The same climate, soil, and mode of culture, however, often produce wines of very different qualities. Position and aspect alone, all other circumstances being the same, make a prodigious difference. The same vineyard, for example, according as its different parts have a northern or southern aspect, will produce wines of opposite characters, as will also the same hill, at its top, middle, and bottom. The

aspect most favourable for a vineyard is upon a rising ground or hill facing the south-east, and the situation should not be too confined:

“————— apertos
Bacchus amat colles.”

If the soil be not favourable for the vine no art can make it so. Manure of different sorts will indeed render the fruit more abundant, but the wine will suffer in quality. The best manure is stated to be the dung of pigeons or poultry. Burnt sea-wrack also is a favourite manure with some. Fat and putrid manures are absolutely to be rejected, as they destroy the wine altogether, by vitiating its flavour.

The qualities of wines are very much affected by the seasons. In cloudy and wet seasons the wine is always inferior. Rain is most to be dreaded at the season of the vintage. Moderate rains just after the season of bloom are of great advantage, and cause the fruit to swell very rapidly. Rough winds are very prejudicial to vineyards. Mists are still more so, especially during the season of bloom, as they are apt to destroy the flower, and consequently the fruit: the reason of this is perhaps not very evident, but it seems to depend in part upon the rapid evaporation of the moisture left by the fogs, when the sun breaks through them, and the great and sudden change of temperature which takes place in consequence. Too great a degree of heat is injurious to the vine; the perfection of their fruit, as well observed by Chaptal, depends upon a due equilibrium between the quantity of water affording aliment to the plant, and the degree of heat necessary to elaborate this water into its juices.

Towards the northern limits of the vine country, the plants are always supported on poles, and in cold and wet seasons they sometimes strip off the leaves, or twist the stalks of the clusters, in order to suppress vegetation and facilitate the ripening of the grapes. The latter practice was not unknown to the ancients: “*Ut dulcior præterea fierent, aservabant uvas diutius in vite, pediculo intorto.*” Pliny. But in warmer climates, on the contrary, the earth requires to be shielded from the heat, and here the vine is generally left to spread over the ground, and thus by its foliage to protect the soil, as well as its fruit, from the direct rays of the sun. With respect to the best methods of pruning and training vines, see the articles VINE, and VITIS.

Of the Vintage.—It is of the utmost importance in the manufacture of wines, to attend to the precise moment when the grapes have arrived at their full maturity; and then, and not before, ought the vintage in general to commence. This may be known, according to Chaptal, by the following signs.

1. The green end of the cluster becomes brown.
2. The cluster becomes pendant.
3. The seed loses its hardness, and the skin becomes thin and transparent.
4. The cluster and seeds are easily detached.
5. The juice is sweet, bland, thick, and clammy.
6. The kernels of the seeds are free from glutinous matter.

The fall of the leaves denotes rather the approach of winter than the maturity of the fruit, especially in the more northern climates. This therefore is a fallacious sign. Nevertheless, when the frost has been so severe as to destroy the leaves, it will seldom be proper to delay the vintage much longer, as the fruit can hardly be expected after this to become ripe; and by delay it may stand a chance of being spoiled entirely.

On the contrary, in the manufacture of particular wines, the grapes are permitted to remain till they wither, or they

are gathered and dried in the sun. Thus the celebrated Tokay wine is made of dried fruit, as are also many of the luscious wines of Italy. Some of the French wines likewise are made with fruit that has been suffered to ripen and wither upon the vines.

It is desirable in general that the weather should be settled, and the soil and fruit dry during the vintage. It is therefore recommended to abstain from gathering till the sun has dispersed the dew. As a general rule, this is proper; but in Champagne they commence gathering the fruit before the sun is risen, and cease their labours about nine o'clock, unless there be a fog, when they continue to gather all day; by these means they improve the whiteness and briskness of their wine, which are the qualities that chiefly render them celebrated. They also increase their quantity. Thus it is found in Champagne, that they gain a tun in every twenty-four where they collect the fruit moist with dew, and a great deal more if there happens to be a fog.

When the fruit is ripe, a proper number of experienced hands should be procured, so as to be able, in a single day, to fill the fermenting tub or vat, in order to ensure an uniform degree of fermentation. Women are commonly employed for the purpose, but the presence of an intelligent male overseer is absolutely necessary. In some parts of France the fruit is separated with scissors; in others with the nail; and in Champagne they use a knife. The scissors is undoubtedly preferable, as it does not shake the flock. The ripe fruit only should be collected, if the object be to make good wine, and what is unripe or decayed should be carefully rejected; indeed they have always two or three separate vintages in those countries, where they are careful of the quality of their wines; and the wine made first is always considered the best. In those parts, on the contrary, where the wine is chiefly distilled, as in Languedoc and Provence, they usually collect all the fruit indiscriminately at one time. In some districts, where the finest wines are made, as in Bourdeaux, &c. the fruit is carefully picked, and only the prime of the clusters taken. On the contrary, they carefully avoid having the fruit too ripe in Champagne, and other districts where sparkling wines are chiefly manufactured, and prefer the presence of a certain proportion of unripe fruit. It need scarcely be remarked, that the greatest care should be taken to prevent the fruit from being bruised or otherwise damaged.

The next important step is the management of the fruit after it has been collected. In different countries different preliminary steps are pursued before the fruit is submitted to pressure. Thus in Spain, especially in the neighbourhood of St. Lucar, they leave the fruit exposed for two days to the rays of the sun. In Lorraine, part of Italy, in Calabria, and the island of Cyprus, as before observed, they dry the fruit completely, and this is the case in the manufacture of all the rich white wines.

A question that has been much agitated is, whether it be advantageous to strip the grapes from the stalks and remove the latter, or suffer them to remain. Both these methods have their advocates; but Chaptal remarks very properly that neither ought to be followed exclusively. It is true, the same celebrated chemist observes, that the stems have a rough and austere taste; but this appears to be of advantage to some wines, especially those made in the more northern districts, where the slight astringency imparted by the stems corrects their insipidity, and appears to have the property of making them keep better, perhaps by rendering the fermentation more complete. In the neighbourhood of Bourdeaux, indeed, they remove the stalks from the red grapes in the manufacturing of their best wines, but they modify that part of the process in some

degree according to the ripeness of the fruit: when the fruit is unripe, or has been injured by the frost, they remove nearly the whole of the stalks, but if the fruit be over-ripe they leave a very large proportion of them. A certain portion, however, is always permitted to remain with the view of facilitating the fermentative process, and rendering it more perfect. From the white grapes, the stalks are never removed. In short, in the colder districts, where the wines are of an inferior quality, or where the object is to render the wines as strong as possible, with the view of distilling them, the stems in general do not require to be removed; but in warmer countries, where the finer-flavoured and richer wines are manufactured, every thing liable to affect these desirable qualities is to be carefully removed, and the stems among the rest. The stems are separated in various ways: sometimes by agitating the grapes in the vessels in which they are deposited with three-pronged forks, sometimes by coarse sieves made of osiers, &c.

The next important step is bruising the fruit, which is generally performed by treading them with the feet in perforated tubs or baskets placed over the vat or tub destined to receive the must. This mode of bruising grapes, though as ancient perhaps as wine-making itself, is very imperfect, as a great deal of the fruit remains unbroken. In England we should adopt the use of machinery.

Of Fermentation, the Circumstances affecting it, Phenomena, Products, &c.—The juice, or *must*, as it is termed, is no sooner in the vat than it usually begins to ferment. The vat is a capacious vessel made of wood or sometimes of masonry, and its size corresponds, or ought to correspond, with the quantity of wine to be made. Before it is used, it requires to be thoroughly washed, and its sides in France are usually covered with lime, which has the effect of saturating a portion of the malic and other acids which exist in abundance in the *must*.

The fermentative process has been already described (see FERMENTATION); we shall therefore be very brief upon the subject here, and confine our attention principally to a concise recapitulation of the particulars, in order to present our readers with a general and connected view of the art of wine-making.

The vinous fermentation is influenced by several circumstances, such as temperature, presence of the air, the volume of the must, &c. The must of the grape requires a temperature of at least 55°, to enable it to commence the fermentative process. Some have denied that the presence of the air is necessary to fermentation. The recent experiments of Gay Lussac, however, seem to prove the reverse. This celebrated chemist found that the must would not begin to ferment in close vessels, but that the introduction of a little oxygen instantly set it going; the oxygen being first rapidly absorbed. Perhaps we may explain the opposite conclusions of different experimentalists upon this subject, by supposing that the presence of oxygen, though necessary to enable the must to commence fermentation, is not necessary to support it afterwards. The fermentative process is much influenced by the bulk or quantity of the must. It is a well-established fact, that the greater the quantity the more violent is the fermentation. An experienced manufacturer of wine, therefore, will take care to proportion the quantity of must to the qualities of his fruit, or rather perhaps to those of the wine which it is his object to procure: the sweeter and more luscious the must, the greater the quantity in general, which it will be proper to submit to the fermentative process in one mass.

Other important circumstances which influence the fermentative process are the requisite quantities and due relative proportions

proportions to one another of the necessary principles. The saccharine and fermentative principles, tartar and water, are the principles (as explained under the article FERMENTATION) essential to the production of wine. The sweetest grapes do not always make the best wine, nor actually contain the greatest proportion of sugar, at least of real sugar, such as is proper for the formation of alcohol. An experienced taste, it is said, can readily distinguish between a really *saccharine* grape and a *sweet* grape; and consequently pronounce *à priori* whether it be adapted for making good wine or not. Pure saccharine matter, however, will not ferment alone, but requires a certain proportion of other principles to put it in motion. When the must contains too large a proportion of water, the fermentative process is feeble, and the wine is consequently bad. The ancients obviated this, as we before mentioned, by boiling the must; a practice still sometimes followed in the northern districts, especially in wet seasons. The same object is gained also by drying the fruit; and sometimes by the introduction of lime into the vat. The juice of the grape always contains a certain proportion of tartar. This quantity is greater in general as the quantity of sugar is less. If the juice contains too large a proportion of sugar in relation to the tartar, it is customary to add a portion of the latter principle. On the contrary, if the saccharine principle be deficient and the tartar in excess, sugar is to be added.

The fermentative process is accompanied by the production of heat, by the disengagement of carbonic acid gas, and the formation of alcohol. These phenomena have been already discussed under the article above alluded to. Another important circumstance, however, which takes place during this process, is the *colouring* of the must. The juice of the black grape, as well as of the white, is nearly colourless; and if the fermentation be not permitted to take place in contact with the husks or *marc*, a colourless wine is obtained in all cases. The colour of red wines is derived from the *marc*, by permitting the wine to ferment in contact with it, the colouring principle of the *marc* or husks being soluble in alcohol. Hence, when alcohol begins to be developed by the fermentative process, it acts upon the colouring principle and dissolves it, and the must becomes coloured. The following are the principal facts connected with this part of the subject. The wine is more coloured the longer the fermentative process is continued, and *vice versa*. The wine is more coloured in proportion as the fruit is more ripe and less watery. Wine obtained by pressure is more coloured than other wine, and lastly wines manufactured in the south are in general deeper coloured than those produced in more northern districts.

Great attention and practical knowledge are required in managing the fermentation properly, as on this important process depend entirely the future qualities of the wines. The same fruit in different seasons, and from various causes, requires to be managed differently; and almost every kind of wine requires a different, and, in some cases, even an opposite, mode of treatment. Thus the fine *bouquet* of Burgundy is completely dissipated by a too violent or lasting fermentation; while, on the contrary, the fermentation of the strong wines of Languedoc, celebrated chiefly for the quantity of alcohol which they contain, ought to be long and complete. In Champagne, as we formerly mentioned, they collect the fruit destined to form their white wines while moist with dew or mist: on the contrary, in the manufacture of their red wines, they prefer fruit as dry as possible. In the former case, the fermentative process is so languid, as often to require a gentle heat; in the latter, so violent, as to require to be moderated. Weak wines ought in general to be fer-

mented in casks; strong wines in the vat. No general rules, however, can be given that will apply in all instances; but the processes must be varied according to circumstances, and the judgment of the manufacturer.

The fermentative process, for obvious reasons, is most difficult to manage in the northern districts, where the fruit is more imperfect. To encourage the process, they sometimes introduce a little warm must to the bottom of the vat by means of a long funnel. They also agitate it frequently, and to preserve a due degree of temperature, cover the vat with blankets, or heat the room artificially.

The theory or rationale of the fermentative process has been explained, as far as it is known, under the article FERMENTATION, before alluded to; we shall therefore pass it over entirely here, and confine our attention to practical points only.

A most material point in the manufacture of wines is to know the precise moment when the fermentative process has been carried far enough, and the means necessary to prevent its getting farther than this point. In the wine countries almost every manufacturer boasts of his knowledge in these particulars, and often adopts different methods. Chaptal lays down the following rules to be attended to.

1. The wine ought to ferment so much the less time as it contains less saccharine matter. Thus the light wines of Burgundy require to ferment no longer than from six to twelve hours.

2. The must ought to ferment a less time in the vat when it is intended to retain the carbonic acid gas, and make sparkling wines. In this case, the must is seldom left longer in the vat than twenty-four hours before it is put into casks; and frequently it is introduced into the casks as soon as it is separated from the fruit; by these means the fermentation is checked, and the carbonic acid gas prevented from escaping.

3. The fermentation ought to be of shorter duration, in proportion as it is the object to obtain wines more free from colour. This should be, therefore, particularly attended to in the manufacture of those wines where the absence of colour is an essential requisite.

4. The fermentative process is more active in warm weather, and when the mass is large, &c. than under the opposite circumstances; and therefore, *ceteris paribus*, is sooner completed.

5. When the object is to preserve to the wine the original perfumed flavour of the grape, the fermentation requires to be checked sooner than under ordinary circumstances.

6. On the contrary, the fermentation requires to be continued longer in proportion as the must is more thick, and the saccharine matter more abundant.

7. It will also require to be longer when the object is to manufacture wines for distillation.

8. It will be longer in cold weather, and especially if the fruit has been gathered on a very cold day.

9. Lastly, it will be longer in proportion as it is the object to make a deeper coloured wine.

These principles steadily kept in view will perhaps be sufficient, with a little practice, to enable any person of ordinary knowledge and powers of observation to decide upon the important points in question.

Great care is requisite in the preparation of the casks for receiving the wine. When they are new, they will spoil its flavour if not prevented. For this purpose, boiling-water, holding salt in solution, is introduced into them, which is frequently agitated, and permitted to remain in them a long time. After this they are to be washed out with a portion of boiling must in a state of fermentation, or sometimes with a little wine, &c. If the casks are old but sweet, the top is merely

merely taken out, and the tartar removed; they are then washed well with warm water. If the casks have acquired a bad odour, Chaptal recommends to commit them to the flames; for though it may be possible to cover in some degree their bad odours, yet they are very likely to re-appear and spoil the wine.

The vessels being ready, the wine is introduced into them, for which purpose it is drawn off from the vat by a cock placed a few inches above the bottom into an open vessel, from whence it is conveyed to the casks. That portion of the wine resting immediately over the must is termed *surmont* in Burgundy. This is carefully defecated, as it constitutes the most delicate and palest of the wine. The liquor is drawn off till the head comes in contact with the *marc*. The head is then carefully removed, and the *marc* is subjected to repeated pressure. The wine thus farther obtained is usually mixed with the rest. That produced by the first pressure is strongest; that obtained by the last is usually more harsh and coloured. Sometimes, however, when it is the object to make vinegar, the *marc* is pressed but once. At other times, they keep the wine obtained by all the different pressures in separate casks. In Champagne they usually mix together the wines obtained by the different pressures, though they are known by different names. The wines obtained without any pressure, or a very slight one, they call *vins gris*; those obtained by the first and second pressure, *ail de perdrix*; those by the third, *vin de taille*, which are most coloured, though sufficiently agreeable.

The *marc* is employed in various ways in the different districts. Some submit it to distillation; others, especially in the vicinity of Montpellier, prepare verdigris from it; others vinegar. In some districts, they feed cattle with it; in others, they burn it for the sake of the potash it yields, &c.

Of the Management of the Wine in the Casks.—The wine receives its last degree of elaboration in the casks; this consists in a sort of fermentative process, to which the name of *insensible fermentation* has been applied. Almost immediately after the wine is introduced into the casks, a scum begins to be formed upon its top, and escapes by the bung-hole, which at first requires to be covered slightly only with a leaf or tile. In proportion as the fermentation subsides, the mass of wine diminishes in bulk; and they watch this cautiously, in order to supply its place from time to time with new wine, so as to keep the cask always full: this process is denominated in France *ouiller*, which may be rendered *filling up*. In some districts they *fill up* every day during the first month, every other day during the second, and every eight days afterwards, till the time of racking. This is the method they adopt with the wines of Hermitage. In Champagne they permit the *vins gris* to ferment in casks for ten or twelve days, and when the ebullition has ceased, they close the bung-hole, leaving, however, a small spigot-hole by its side, which is permitted to remain open for eight or ten days longer; after which they close this with a plug, in such a manner as to be able to open it at pleasure. When the bungs are introduced, they *fill up* every eighth day by the spigot, for twenty-five days. After this every fifteenth day, for one or two months; and finally, every two months during the whole time the wine remains in the cellar. When the season has been wet and unfavourable, and the wines want body, or when it has been dry and hot, and they are too rich, twenty-five days after they have been made, they roll the casks five or six times, in order to mix the grounds, and re-excite the fermentative process, and this they repeat every eighth day for a month.

The fermentation of the Champagne wines, which are designed to be brisk and sparkling, is very long and tedious.

It is generally understood that they will be sparkling, provided they are bottled any time between the vintage and the following May, and that the nearer the vintage the brisker they will be. It is, however, generally taken for granted, that they will be sufficiently sparkling if bottled about the middle of March. Wines begin to sparkle in about six weeks after they have been bottled; those, however, produced on mountains become sparkling sooner than others. Wines bottled in June and July will be very little sparkling, and quite *still* if bottled so late as October and November.

In Burgundy, after the fermentation has relaxed in the cask, they put in a bung pierced with a small hole, in which they introduce a plug that can be easily removed at pleasure, in order to suffer the gas that may be extricated to escape. In the district of Bourdeaux, they begin to *fill up* eight or ten days after the wine has been introduced into the cask. A month after this they introduce the bung, and *fill up* every eight days. At first they bung the casks loosely, and then fasten them down by degrees, without running any risk. The white wines are racked and sulphured in December, and these require much more care than the red wines, from their containing more sediment, and their being more liable to become ropy. The red wines are not racked till towards February or March, and as these are much more apt to become sour than the white wines, they require to be kept in cooler cellars during the summer. There are some who, after the second racking, turn the casks so as to place the bung on one side; and thus the casks being hermetically sealed from there being no loss, there is no need of *filling up*. They then rack off annually, at any time of the year they find it convenient.

Methods nearly similar are adopted in other wine countries; hence it will be needless to repeat them. We shall, however, give a short account of the methods followed in the manufacture of *Port*, *Madeira*, and *Sherry*, the most popular wines of this country.

In *Oporto*, the complete fermentation of the must takes place in the vat. The wine is then introduced into large tuns, capable of holding twenty-five pipes each; and at this stage the brandy is added according to the judgment of the manufacturer.

In *Madeira*, the second or insensible fermentation is carried on in casks, and the wine is racked from them at the end of three or four months, at which time a portion of the brandy is added. The remainder is reserved to be mixed at the time of exportation.

In the manufacture of *Sherry*, the grapes are first slightly dried, and sprinkled with quick-lime. They are then wetted with brandy on being introduced into the prefs, and a portion of brandy is added to the must before the fermentation commences. The subsequent processes consist in repeated rackings at intervals of a month or two, till March, brandy being added at each racking.

The object of racking the wines is to separate the dregs consisting of tartar, &c. deposited from the wine, and which, if left, are liable to render it sour, by re-exciting from time to time the fermentation. The tendency to fermentation is counteracted by a process termed *sulphuring*, and the spontaneous separation of the dregs is rendered more complete by CLARIFICATION, which see. See also FINING and FORCING.

The *sulphuring* of wines consists in impregnating them with the vapours of burning sulphur, or sulphurous acid, and is generally effected by burning sulphur-matches in the casks. (See MATCHING.) These matches are made in different ways, aromatics being sometimes mixed with the sulphur; but the sulphur is the only useful and necessary ingredient.

Sometimes

Sometimes a wine highly impregnated with fulphurous acid is prepared, a little of which mixed with the rest answers the purpose of burning matches in the cask. Other substances, according to Dr. Macculloch, answer the same purpose as *sulphuring*; namely, the *black oxyd of manganese*, and particularly the *sulphite of potash*. A drachm of which salt is sufficient for a pipe of wine, and is very effectual in counteracting the fermentative process. The theory of these processes is very obscure.

We have before observed that the mere racking of wines is not sufficient to render them pure, and various methods are adopted at the racking periods to render this operation more effectual, and these altogether constitute the process termed *clarification*.

Lord Bacon mentions a practice among the ancients of putting wine into vessels well stopped, and letting it down into the sea. That this practice is very ancient is manifest from the discourse of Plutarch (*Quæst. Nat. 27.*) about the efficacy of cold upon must.

Different periods, as before-mentioned, are chosen in different districts for racking wines. Thus the wines of Hermitage are racked in March and September, those of Champagne about the middle of October, the middle of February, and the latter end of March. If possible, a serene and settled state of the atmosphere, and a dry and cold day, should be chosen for the purpose, as the wine is always turbid in damp close weather, and during the prevalence of southerly winds.

In racking wines, it is in general desirable to expose them as little as possible to the atmospheric air. In some districts, a syphon is employed for the purpose. In Champagne they use a fort of pump. Dr. Macculloch recommends that the wine should be transferred from one cask to another by means of a leather hose, and this method is undoubtedly preferable. For clarifying wines, a great variety of substances are employed. Ifinglass and albumen either from eggs or blood are the most common; but gum, starch, rice, milk, the shavings of beech-wood, gypsum, sand, &c. are used in different wine countries. An ounce of ifinglass, or about eighteen or twenty whites of eggs, are sufficient for one hundred gallons of wine.

Two very important circumstances in the practice of wine-making require yet to be mentioned; these are the *medication* of wines, and the means of *remedying those diseases* to which they are liable.

The *medication* of wines consists in altering the colour, the flavour, or the strength of any given wine, or in so mixing two or more together, as to produce a compound differing from, or superior to, either. It is difficult to give any general rules for this purpose, and the proper management of the processes depends chiefly upon the experience and taste of the maker.

It generally happens that when two wines are mixed, the fermentative process is partially renewed, or the mixture is technically said to *fret*, whence the practice itself has derived the name of *fretting in*. Mixed wines appear to unite into one durable and homogeneous liquor, only in consequence of this fermentation. It is therefore desirable, if possible, to mix wines only at those periods when they both shew a tendency to *fretting*, which, according to Chaptal, in the wine countries, appears to be at three principal seasons of the year, *viz.* when the vines begin to shoot, when they are in flower, and when the fruit begins to acquire colour. The wines being then proportioned according to the fancy or experience of the maker, a strong fermentation is excited, which is still farther assisted by agitation. The wine thus becomes homogeneous, and shews no more tendency to far-

ther change than if it had been originally produced by one operation; and the repetition of the processes of *fining and racking* renders it perfect.

In wine countries, particular wines, distinguished either by their strength, harshness, colour, or flavour, are often manufactured for mixing with others, and are applied according to circumstances. For making such wines, different fruit and peculiar management are often resorted to. The usual faults of wines requiring correction are, *sweetness*, *dryness* bordering on *acidity*, and excess or defect of *briskness*. Connected also with this part of the subject are the means of imparting to wine *colour*, *flavour*, and *strength*, and other remarkable properties. *Sweetness* arises from the presence of too much saccharine matter, and may be generally remedied by prolonging the fermentation. On the contrary, when the fermentation has been carried so far as to decompose the whole of the sugar, the wine is said to be *dry*; and if the original quantity of sugar has been rather defective, it will have a strong tendency to become sour. The remedy in this case is, to add sugar, or sometimes brandy. The modes of ensuring a due degree of *briskness* in those wines intended to possess this quality have been already pointed out.

Many of the processes followed in imparting *colour*, *flavour*, *strength*, &c. to wines, are unknown to the public, and confined to the cellars of the manufacturer or the merchant. The general principles, however, are sufficiently obvious. The *roughness* and *colour* of red wines are derived, as we formerly stated, from the husks of the fruit; and when it is wished to impart these qualities in a higher degree, the manufacturers sometimes mix a certain portion of wild and high-coloured grapes with the other fruit. At other times, various astringent and coloured drugs are employed, as catechu, kino, logwood, &c.: popular ingredients are the juices of sloes or elderberries. The chips of oak and beech-wood are also employed. With respect to yellow tints, these can be all accurately imitated by means of burnt sugar. As to *flavours*, in general those which are foreign and unusual are commonly unpleasant. Custom, however, has reconciled us to many. The ancients, as formerly mentioned, seem to have been much more accustomed to artificial flavours than the moderns, and the most in request was the turpentine or resinous flavour, which was imparted by means of chips of fir-wood, a practice still followed in modern Greece. In Madeira wines, as well as those of Xeres and San Lucar, it is the practice at present to use sweet and bitter almonds; hence the *nutty* flavour of these wines. In Egypt, the flower of the vine itself has been employed from time immemorial, and is still used in different wine countries; its odour is very like that of mignonette, which may be doubtless substituted for it. Raspberries, orris-root, elder-flowers, worm-wood, and a variety of other substances, are employed for a similar purpose. In using these different articles, the established practice is to suspend the flavouring ingredients in the cask a few days during the stage of insensible fermentation; by which means their flavour is retained without a chance of being dissipated. Where the *strength* of wine is deficient, brandy is added, according to circumstances; and to render the mixture of this more complete, it should be added while the process of insensible fermentation is going on. If there be a necessity to add it after the wine is completed, it should then be managed by the *fretting-in* process.

The last of the circumstances connected with wine-making is the means of *obviating those diseases* to which wines are liable.

One of the most common diseases of weak wines is *acidity*.

Strong

Strong wines, for obvious reasons, seldom become four. When acidity is present only in a very slight degree, it may be palliated considerably by fugar, or by the addition of must concentrated by boiling. It is obvious, however, that the acid can only be got rid of by neutralizing or destroying it. For this purpose, the alkalies and alkaline earths have been employed, but they impart a disagreeable flavour to the wine. Of these substances, lime is the safest and best. It was formerly the practice to employ lead, in some form or other, for counteracting acidity in wines; but we trust that this murderous practice has been long since laid aside. *Ropiness* is another disease to which wines are liable. This occurs more particularly in those which contain a good deal of extractive matter. It may be much relieved, and sometimes cured, by exposing the bottles to the sun and air, by agitating and subsequently uncorking them, by adding a small quantity of vegetable acid, and by fining. The last disease we shall notice is perhaps the most formidable of any, namely, a *mustiness*, or other *ill-flavour* communicated by the cask or cork. This appears to be, in general, absolutely incurable, though it may be sometimes diminished by agitating the wine in contact with the air, or by the introduction of common air or carbonic acid by pumping. Such is a summary account of wine-making from grapes, as practised in the countries where that delicious fruit comes to perfection, and more especially in France. (See Birch's Hist. of the Royal Society, vol. i. p. 156.) We come now to consider,

2. *The Manufacturing of Wines from other Fruits, or artificial Wines.*—In the above sketch we have endeavoured to present our readers with a general view of the principles of wine-making, at the same time that we described the practice. These principles are equally applicable to the manufacture of wine from all sorts of fruit; we shall therefore take the present opportunity of briefly recapitulating them here, as they cannot be too strongly impressed upon the memory, and as they at the same time constitute the most appropriate introduction to the present section that occurs to us.

The juice of the grape consists of a large proportion of water, holding in solution certain proportions of *saccharine matter*, of the *sweet or fermenting principle*, which appears to be a modification of the saccharine principle, of *various acids*, especially the tartaric and malic, and of various ill-defined *extractive matters*. These principles, left to themselves for a short time in a medium temperature, soon begin to re-act upon one another, and some of them at length undergo remarkable changes. This process is termed *fermentation*, and constitutes the grand principle of wine-making. When this process has begun to subside, it will be found that the greater portion of the saccharine principle has disappeared, and that its place is supplied by a corresponding portion of ardent spirit or alcohol. This is the most striking feature of the change that has taken place, but all the other principles of the juice or *must* appear to have undergone likewise some change either in quality or quantity. In short, the sweet and crude *juice* of the grape is found to be converted into *wine*.

In this state, the *wine* is introduced into casks, where it undergoes further changes, and is matured by a modification of the fermentative process, which has been called the *insensible fermentation*. This is a most important step in the process of wine-making, as by different modes of management in this stage almost the whole of that infinite variety which exists among wines is produced. Here also it is that all foreign substances designed to impart flavour, &c. to wines are in general introduced with the greatest pro-

priety. When the *insensible fermentation* has been carried to the point desired, it is checked by the processes of *racking*, *sulphuring*, *clarification*, &c.; and thus the wine is rendered capable of being preserved at any point or state we choose.

Let us now apply these principles to the manufacture of wines from other fruits.

We start upon the grounds that artificial wines are intended to be imitations of wines prepared from grapes. In the first place, therefore, we have to prepare a juice or must similar to the juice or must of the grape in its general composition. Now, no fruit whatever yields a juice precisely similar to that of the grape. In our northern climate more especially, the saccharine principle, which is the fundamental principle in wine-making, exists in very minute proportion in most fruits. It must be, therefore, supplied artificially. The tartaric acid, or rather *tartar*, which appears to be another essential principle in wine-making, is likewise wanting in most of our fruits. This, therefore, must be supplied. On the contrary, other principles, and particularly the malic acid, appear to exist in too large a proportion in most of our fruits, which, in their natural state, are thus better adapted for making *cyders* than wines. To get rid of the malic acid, and to prevent its deteriorating effects, as well as the deteriorating effects of other foreign principles, is difficult, or perhaps impossible; and this will doubtless always render artificial wines in general inferior to those of the grape, though very near approaches may be made by judicious management.

The practical mode of obviating these difficulties is to dilute the juice of the fruit to such a degree, that a given quantity of it when diluted shall contain no more of the malic acid, for example, than a given quantity of the juice of the grape; and, as before observed, to supply artificially the two grand principles, sugar and tartar, which are wanting. Having thus prepared an artificial must, as nearly resembling in its composition that of the grape as possible, the application of the other principles will be obvious, as we have nothing to do but to manage, in general, all the subsequent processes precisely as if we were operating upon the must of the grape. We shall now, therefore, descend from generals to particulars, and, after having made a few remarks upon our native fruits, endeavour to point out the modes in which the more important foreign wines may be best imitated by them.

Fancy or caprice has led to the formation of wine from an infinite variety of substances, and almost every good housewife boasts of some favourite *receipt* for making wines from what nature never intended for the purpose. Such compounds hardly deserve the name of *wine*; we shall, therefore, principally confine our attention to *fruits*. The following are the domestic fruits most usually employed for the purpose:

Gooseberry, and three varieties of currant.
Strawberry, raspberry, blackberry, mulberry.
Sloe, damson, elderberry.
Quince, cherry.
British grapes.

To them may be added the foreign fruits

Raisins.
Orange, lemon.

The gooseberry and currant are of all others the fruits most commonly employed for the fabrication of artificial wines; and, perhaps, upon the whole, they are best adapted for the purpose. When used in their green state, both gooseberry and currant may be made to form light brisk

WINE.

brisk wines, falling little short of Champagne. Ripe gooseberries are capable of making sweet or *dry* wines; but these are commonly ill-flavoured, particularly if the bulk has not been carefully excluded. Ripe currants, if properly managed, make much better wines than gooseberries. These fruits are much improved, according to Dr. Macculloch, by boiling previously to fermentation. This, he states, is particularly the case with the black currant, which, when thus managed, is capable of making a wine closely resembling some of the best of the sweet Cape wines.

The strawberry and raspberry are capable of making both *dry* and sweet wines of agreeable quality. As commonly managed, however, their peculiar flavour is dissipated in the process; hence, as Dr. Macculloch observes, little is gained by their use to compensate for their comparatively high price. A simple infusion of these fruits, in any flavourless currant wine during the period of insensible fermentation, will, with greater cheapness and certainty, ensure the production of their peculiar flavour. The blackberry and mulberry are capable of making coloured wines, if managed with that view: they are deficient, however, in the astringent principle; nevertheless, they may be occasionally employed with advantage when a particular object is to be gained.

The sloe and damson are so associated in qualities, that nearly the same results are obtained from both. Their juice is acid and astringent; and hence they are qualified only for making *dry* wines. By a due admixture of currants or elderberries with sloes or damsons, wines not much unlike the inferior kinds of port are often produced. The elderberry is capable of making an excellent red wine. Its cheapness also recommends it. It does not, indeed, possess any great degree of flavour, but it possesses no bad one, which is a negative property often of great importance in artificial wine-making.

The quince, from its analogy to the apple and pear, is better qualified for making a species of cyder than wine. The cherry produces a wine of no very peculiar character. If used, care should be taken not to bruise too many of the stones, otherwise a disagreeable bitter taste will be imparted to the wine.

Grapes of British growth are capable of making excellent sparkling and other wines, by the addition of sugar. Dr. Macculloch informs us, that he has succeeded in making wines from immature grapes and sugar so closely resembling Champagne, Grave, Rhenish, and Moselle, that the best judges could not distinguish them from foreign wines. The grapes may be used in any state, however immature; when even but half grown and perfectly hard they succeed completely.

The cottagers in Sussex, says Dr. Macculloch, are in the habit of making wine, almost annually, from the produce of vines trained on the walls of their houses. Many individuals through various parts of the southern counties, and even as far north as Derbyshire, practise the same with success. But the experiment is well known to have been made for many years on a large scale, and with complete results, at Pain's-hill, by the Hon. Charles Hamilton, in a situation with respect to soil and exposure of which parallel instances are to be found throughout the country, and produced from land of no value whatever for the ordinary purposes of agriculture. That our ancestors made wine from the produce of their vineyards there can be no doubt, and Dr. M. justly remarks, that we can still make by far better wine from our grapes, even as produced at present, than from any other fruit whatever. These, therefore, are cogent reasons for the cultivation of the vine, especially as, the same

gentleman observes, we might, with care, inure and domesticate to our climate many of the richer and more delicate varieties of southern latitudes. See VINE, and VARIETIES; under the last of which articles some interesting experiments on this subject are related.

Raisins are extensively used in this country for making domestic wines, and also for the fraudulent imitation and adulteration of foreign wines, although not a native fruit; therefore they deserve to be mentioned here. When properly managed, they are capable of making a pure and flavourless vinous fluid, well adapted for receiving any flavour which may be required, and thus of imitating many wines of foreign growth. See the close of this article.

The orange and lemon are likewise used for making domestic wines. Upon the whole, however, they are not very well adapted for the purpose, as they contain too much acid, and too little of the extractive and of the sweet or fermentative principle.

From what has been said of the manufacture of wine from grapes, our readers will observe, that different methods are pursued, according to the kind of wine which it is intended to make. Now these remarks are equally applicable to artificial wines, in the manufacture of which it is absolutely necessary that the maker should determine beforehand upon the kind of wine which it is his object to produce, and to modify his processes accordingly. We may, with Dr. Macculloch, consider wines as of four general descriptions: *sweet* wines; *sparkling* or *effervescent* wines; *dry* and *light* wines, analogous to hock, grave, and Rhenish, in which the saccharine principle is entirely decomposed during fermentation; and lastly, *dry* and *strong* wines, as Madeira and sherry.

Those of the first and most simple class are the *sweet* wines, or those in which the fermentative process has been incomplete. It is to this class that by far the greater number of our artificial wines bear the greatest resemblance; a resemblance, says Dr. M., so general as to shew that few makers of this article possess sufficient knowledge of the art to enable themselves to steer clear of what may be firmly called the radical defect of domestic wines. *Sweet* wines may be made from almost any ripe fruits. Those most generally employed, however, are the gooseberry and currant. We shall suppose that we wish to make the quantity of ten gallons of sweet wine from one or other of these fruits.

For this purpose, the following are the proportions and other circumstances to be attended to. Forty pounds of fruit are to be introduced in a clean and sufficiently capacious tub, in which it is to be bruised in successive portions, by a pressure sufficient to crush the berries without breaking the seeds, or if gooseberries be employed, without materially compressing the skins. Four gallons of water are then to be poured into the vessel, and the contents are to be carefully stirred and squeezed in the hand until the whole of the juice and pulp are separated from the solid matters. The materials are then to be permitted to remain at rest for a period of from six to twenty-four hours, when they are to be strained through a coarse bag by as much force as can be conveniently applied to them. One gallon of fresh water may afterwards be passed through the *mare*, for the purpose of removing any soluble matter which may have remained confined. From thirty to forty pounds of sugar, according to the desired strength and sweetness of the wine, and about six ounces of cream of tartar, or, what is better, crude tartar, are now to be dissolved in the juice thus procured, and the total bulk of the fluid made up with water, to the amount of ten gallons and a half.

The liquor thus obtained is the artificial *must*, which is

equivalent to the juice of the grape. It is now to be introduced into a tub of sufficient capacity, which is to be well covered, and placed in a temperature varying from 55° to 60°. Here it is to remain two or three days, more or less, according to the symptoms of fermentation which it may shew, and from this tub it is to be drawn off into the cask, where the fermentative process is intended to be brought to the point desired. As the fermentative process proceeds the bulk of the liquor diminishes, and its place must be supplied from time to time by the superfluous portion of must made for the purpose, so as to keep the liquor always near the bung-hole. When the fermentation has subsided a little, the bung may be driven in, taking care, however, to leave a small hole open by its side, which may be stopped with a peg, and opened occasionally to give vent to any air that may be generated.

When the wine has arrived at the desired point of sweetness, &c. it must be racked and clarified in the manner described in the former part of this article; and these processes must be repeated, and the casks sulphured, if necessary, in order to prevent the fermentative process from proceeding farther. In general, however, one racking in the following December or January will be sufficient, after which it may be kept in the cask for any length of time, or it may be bottled without the usual precautions. A fine serene and cold day should be chosen for these operations. Sometimes the fermentative process will stop before the wine has arrived at the desired point, in which case it may be commonly easily re-excited by raising the temperature, and shaking the cask; or, if these fail, by having recourse to the means formerly described for that purpose.

By attending to these general directions, sweet wines may be made from other fruits, care being taken to increase or diminish the quantity of sugar according to the natural sweetness of the fruit employed.

The second general description of wines comprehends the *brisk* or *sparkling* wines; which may be, at the same time, either *sweet* or comparatively *dry*. Our readers will recollect the methods adopted in Champagne, and other countries where they manufacture sparkling wines from the grape, and which are described in the former part of this article. Now these principles are to be held in view in the manufacture of artificial wines intended to possess similar properties. The fruits most generally employed for forming wines of this description, are the immature gooseberry and currant; sometimes also immature grapes, and even vine leaves are made use of for a similar purpose, but grapes are doubtless preferable when they can be procured. Wines of this description are more difficult to be made than the last, at least they require much more care. If gooseberries are employed, they must be gathered when they have nearly attained their full growth, but before they have shewn the least tendency to ripen. The variety of gooseberry is perhaps indifferent, but it will be advisable to avoid the use of those, which in their ripe state have the highest flavour. Dr. Macculloch recommends the *green bath* as among the best. Those which are unsound, as well as the remains of the blossom and footstalk, should be carefully removed. Forty pounds of this fruit, thirty pounds of fine white sugar, and about six ounces of tartar, are sufficient for making ten gallons of wine. All the preliminary processes are to be conducted precisely in the same manner as those above-described for making sweet wines. The *must*, however, ought to remain in the fermenting tub for about twenty-four hours, or two days only, when it is to be transferred to the cask, and the processes of *filling up*, &c. managed as before, except that the wooden peg or spile must be permanently tightened as soon as the danger of bursting the cask

has subsided. The wine thus made may commonly remain during the winter in a cool cellar, as it is no longer necessary to excite the fermenting process. To ensure its fineness, however, it is a good practice to draw it towards the end of December into a fresh cask, so as to separate the lees; and if at this time it should prove too sweet, instead of decanting, it will be better to stir up the lees so as to renew the fermenting process, taking care also to increase the temperature at the same time. At whatever time the wine has been decanted, it is to be fined with isinglass in the usual manner. Sometimes it will be necessary to decant it a second and even a third time into a fresh cask. All these operations should take place, as formerly mentioned, in dry cool weather, and the wine must, at any rate, be finally bottled in March. If immature currants be employed, which are perhaps upon the whole preferable to gooseberries, the same proportion of fruit, sugar, and tartar, and the same modes of management, may be had recourse to; care being taken to separate carefully the stalks of the currants. If grapes be used for the purpose, they may be safely taken of different degrees of ripeness, nor is it necessary to attend to the selection of any particular variety. The same proportions of fruit and sugar will be proper as when gooseberries and currants are employed, but the tartar must be omitted. The husks also may be permitted to ferment with the liquor in the vat. The subsequent management is to be precisely the same as that described above. An excellent wine of the present description may be made from the leaves and tendrils of the vine. About forty pounds of these, and twenty-five or thirty pounds of sugar, will be sufficient for ten gallons of wine. To prepare it, seven or eight gallons of boiling water are to be poured upon the leaves in a tub, and permitted to remain for twenty-four hours. The liquor being poured off, the leaves must be strongly pressed, and subsequently washed with another gallon of water. The sugar and the remainder of the water are then to be added, and the fermentative and all the subsequent processes conducted precisely the same as before. The present class of wines, if the process has been successful, (which is not always the case), is brisk, and precisely similar in their qualities (flavour excepted) to the wines of Champagne, with the strength of the best Sicily.

The third variety of wines is that of which hock, grave, and Rhenish may be taken as examples. In these the saccharine principle is entirely overcome by a complete fermentation, while their future change is prevented by a careful application of the processes laid down for the preservation of wines of this class. Makers of domestic wines have rarely, says Dr. Macculloch, succeeded in imitating these wines. The reasons obviously are, the great disproportion of the sugar to the subsequent fermentation in the first instance; and that want of the after-management, the neglect of which soon consigns these wines to the vinegar cask, if chance should even at first have produced success. In making these wines, the relative proportion of fruit and sugar in common use must be materially altered, and the fermentative process be conducted in a very careful manner. The subsequent processes also of racking, sulphuring, and fining, must be practised with great assiduity, in order to preserve these wines after we have succeeded in making them. Dr. Macculloch states, from his experience, that these wines may be successfully imitated, and that they constitute some of the very best of those which can be made from domestic fruit. The proportion of fruit (generally of immature fruit) to the sugar, in the manufacturing of sweet wines, must be the greatest. The bung must remain open, but the fluid within must not be allowed to escape, while, if the fermentation proceed

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ceeds languidly, it must be accelerated by heat and agitation. If, when it is finished, the wine continues too sweet, it may be bunged down till the spring without racking or fining, when the fermentation must again be renewed. The renewal of the fermentation may also be effected by adding some fresh juice of the same fruit. At whatever time, and under whatever of these processes, it has become *dry*, it is to be carefully fined and racked into a sulphured cask, and bottled, after being once more carefully fined.

The fourth and last class of wines consists of those which are both dry in their quality, and strong in their nature; such are, Madeira, sherry, &c.; the theory of these, from what has been said, will be sufficiently apparent. With due attention to the fermentative process, such wines may be made of the requisite degree of strength without brandy. By means of this, however, if managed as formerly directed, the operator has it always in his power to produce wines of any required degree of strength.

We need not here repeat the methods of imparting different flavours to domestic wines, or of correcting their faults, since they differ in no respect from those recommended to be adopted in the manufacture of wines from grapes, to which therefore we refer.

The following general remarks upon the fabrication of domestic wines, will not perhaps prove uninteresting to our readers.

The great radical defect in the manufacture of domestic wines, is using too small a proportion of fruit compared with the sugar employed. It is this circumstance chiefly which renders the fermentative process incomplete, and thus imparts that sweet and mawkish taste to our domestic wines, which renders them intolerable to many people, and even to all, perhaps, without the addition of brandy. The proportions of fruit and sugar given above may be considered as mean standards, which may be varied either way, according to circumstances and the nature of the wine intended to be produced. A very superior class of fruit wines may be manufactured by using the juices of our different fruits, either alone or very slightly diluted with water.

We mentioned that some fruits, and especially the black currant, were much improved by boiling. For this purpose, it will be sufficient that the fruit be simply brought to the boiling point before using it, the water in the vessel being so managed as to avoid any risk in burning. The black currant thus treated, and subsequently managed upon the principles we have endeavoured to lay down, is capable of making a wine very nearly resembling some of the best sweet Cape wines.

The fermentative process being rendered tardy and incomplete, by the improper adjustment of the sugar to the fruit, is frequently endeavoured to be excited by *yeast*: nothing can be more injudicious than this. *Yeast* invariably spoils wines, by imparting to them a flavour that nothing will ever overcome. The only ferment to be employed in wine-making, is that furnished by nature; and when this is defective, as is sometimes the case in our domestic fruits, the ferment of the grape must be supplied artificially. This may be done by introducing a certain proportion of *crude tartar*, the dose of which may vary from one to six *per cent.* without materially affecting the wine, as a great proportion of what escapes decomposition will be subsequently deposited. All fruits, except the grape, will require more or less of *tartar*.

The last circumstance we shall notice is the introduction of *brandy*, or other spirit, into domestic wines. As commonly manufactured, they often require, as we have just stated, this addition to render them tolerable. We trust,

however, that from the attention that has been lately paid to the subject of artificial wines, the modes of manufacturing them will be better understood, and that this will no longer be the case. Fine wines are invariably spoiled by the addition of ardent spirit, which seems to have the effect of slowly decomposing them, and thus of destroying that delicate, lively, and brisk flavour, so eminently possessed by all natural wines. Hence it is seldom or never used in wine countries; or rather it is confined to the manufacture of those wines destined for this country, where only this barbarous practice is tolerated. We again repeat, that if the fruit and sugar be duly adjusted to one another, and the fermentative process be properly managed, an infinitely better wine will be produced without the use of brandy, than can ever be produced with it.

General Chemical Properties and Composition of Wines.—The juice of the grape, as we formerly mentioned, consists of a large proportion of water, of certain proportions of the saccharine and fermentative principles, of various acids, especially the tartaric, and some ill-defined extractive principles. These were stated during the fermentative process to undergo different remarkable changes, one of the most important of which is the conversion of the saccharine principle into alcohol. The nature of the other changes are not so well understood, nor does the little we know at present of the composition of wines throw any very satisfactory light upon the subject. One principle indeed, *viz.* the fermentative principle, does not exist in perfect wines, and therefore must be decomposed or separated during the process of fermentation. The principles formed in wines may perhaps be arranged under the four following heads: 1. *Acids*; 2. *Extractive and colouring matters*; 3. *Essential oils*; and 4. *Alcohol*. Water is not mentioned, because it forms the basis of all potable fluids, and consequently of wines.

1. *Acids.*—All acids have the property of reddening turnsole or litmus papers, and therefore contain more or less of a free acid. The acids found in wines are, the tartaric, the malic, the citric, the carbonic, and occasionally the acetic.

The tartaric acid, in combination with potash, or *tartar*, as it is usually termed, exists in great abundance in the juice of grapes, as formerly stated, and appears to be one of its most important ingredients. A large proportion of this tartar is doubtless decomposed during the fermentative processes, and a considerable quantity of what remains is subsequently deposited in the casks or vessels in which the wine is kept, constituting what is termed the *crust*. It appears probable, however, that the whole is not separated, and consequently, as Dr. Thomson justly remarks, that wines are never entirely destitute of tartar. Satisfactory experiments, however, upon an extensive scale, are at present wanting upon this part of the subject. The malic acid, according to the experiments of Chaptal, exists in the greater number of wines, if not in all, and that in much greater proportion than any other acid. If this be really the case, it is probably, in part at least, a product of fermentation, for the juice of grapes appears to contain very little of this acid. Traces of the citric acid were found by Chaptal to exist in some wines. This acid also exists in the juice of the grape, but in small quantity. All wines that have the property of effervescing, or sparkling, when poured from the bottle into a glass, contain carbonic acid. Champagne, for example, owes its characteristic properties to this acid. Sparkling wines are usually weak, and contain less alcohol than usual, for reasons that have been already explained. The acetic acid is not an essential ingredient of wine, nor in fact ought it ever to exist in it. If

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the fermentation, however, be permitted to go too far, this acid will be formed, and hence it occasionally occurs in inferior wines.

2. *Extractive and colouring Matters.*—These ill-defined substances exist more or less in all wines. Their properties, however, are not well ascertained, nor are they probably uniformly the same in every instance. They have a tendency to separate spontaneously, and along with the tartar form what is termed the *crust*; hence, as wines become older, from their containing less of these matters, they usually become paler. These extractive matters may be also separated artificially by means of animal charcoal, the subacetate of lead, and even partially in some instances by lime-water, or the heat of the sun. The colouring matter, as we formerly noticed, is not derived from the juice of the grape, but from its husk.

3. *Essential Oils.*—Wines, though essentially the same in their general composition, are distinguished from one another principally by their flavour and odour, no less than by the proportion of alcohol they may contain. Now their sensible properties evidently depend upon some volatile and fugacious principle, which has been considered to be analogous to an essential oil. This principle is sometimes derived immediately from the fruit, as, for example, in the wines made from the Frontignac and Muscat grape. At other times, it

is the product of fermentation. Thus the finer flavours of claret, hermitage, and Burgundy, bear no resemblance to those of the grapes, from whence they are formed. Very often, as before stated, the principles of odour and flavour are communicated to wines artificially, by the introduction of foreign ingredients, as orris-root, grape, and elder-flowers, mignonette, &c. The menstruum of this volatile principle is doubtless, in most instances, the alcohol contained in wines; but its quantity is so minute as to be incapable of separation.

4. *Alcohol.*—The characteristic ingredient of wines is alcohol. Indeed, wines may be considered as more or less dilute solutions of alcohol, impregnated with different flavouring substances, and a little acid. There have been great differences of opinion in what state alcohol exists in wines. Some chemists maintain, that alcohol does not exist ready formed in wines, but that its elements only exist in a peculiar state, and that their union is determined, and consequently alcohol formed, by the act of distillation. This opinion was advanced by Fabroni, and seems to have been adopted by some subsequent writers. Mr. Brande, however, has shewn by very decisive experiments, that all wines contain alcohol ready formed, and that this fluid is merely separated during the distillation of these liquors; and his experiments have been since fully confirmed by Gay Lussac.

The following Table, representing the Quantity of Alcohol and other Principles in different Wines, is taken from Dr. Thomson's Chemistry, though it was compiled originally by Neumann. The results are not absolutely to be relied upon, as the state of chemical Knowledge, at the time Neumann wrote, was very imperfect.

A Quart of contains	Highly rectified Spirit.			Thick, oily, unctuous, resinous Matter.			Gummy and tartareous Matter.			Water.			
	oz.	dr.	gr.	oz.	dr.	gr.	oz.	dr.	gr.	lb.	oz.	dr.	gr.
Aland - - - - -	1	6	0	3	2	0	1	5	0	2	5	3	0
Alicant - - - - -	3	6	0	6	0	20	0	1	40	2	2	6	0
Burgundy - - - - -	2	2	0	0	4	0	0	1	40	2	9	0	20
Carcaffone - - - - -	2	6	0	0	4	10	0	1	20	2	8	4	30
Champagne - - - - -	2	5	20	0	6	40	0	1	0	2	8	3	0
French - - - - -	3	0	0	0	6	40	0	1	0	2	8	0	20
Frontignac - - - - -	3	0	0	3	4	0	0	5	20	2	4	6	30
Vin de Grave - - - - -	2	0	0	0	6	0	0	2	0	2	9	0	0
Hermitage - - - - -	2	7	0	1	2	0	0	1	40	2	7	5	20
Madeira - - - - -	2	3	0	3	2	0	2	0	0	2	4	3	0
Malmsey - - - - -	4	0	0	4	3	0	2	3	0	2	1	2	0
Vino de monte Pulciano - - - - -	2	6	0	0	3	0	0	2	40	2	8	0	20
Mofelle - - - - -	2	2	0	0	4	20	0	1	30	2	9	0	10
Muscadine - - - - -	3	0	0	2	4	0	1	0	0	2	5	4	0
Neufchatel - - - - -	3	2	0	4	0	0	1	7	0	2	2	7	0
Palm sec - - - - -	2	3	0	2	4	0	4	4	0	2	2	5	0
Pontac - - - - -	2	0	0	0	5	20	0	2	0	2	9	0	40
Old Rhenish - - - - -	2	0	0	1	0	0	0	2	20	2	8	5	40
Rhenish - - - - -	2	2	0	0	3	20	0	1	34	2	9	1	6
Salamanca - - - - -	3	0	0	3	4	0	2	0	0	2	3	4	0
Sherry - - - - -	3	0	0	6	0	0	2	2	0	2	0	6	0
Spanish - - - - -	1	2	0	2	4	0	9	4	0	1	10	6	0
Vino Tinto - - - - -	3	0	0	6	4	0	1	6	0	2	0	6	0
Tokay - - - - -	2	2	0	4	3	0	5	0	0	2	0	3	0
Tyrol red wine - - - - -	1	4	0	1	2	0	0	4	0	2	8	6	0
Red wine - - - - -	1	6	0	0	4	40	0	2	20	2	9	3	20
White - - - - -	2	0	0	0	7	0	0	3	0	2	7	0	0

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The following Table has been given by Mr. Brande, representing the quantity by measure of alcohol, sp. gr. .825, contained in different wines, and other fermented liquors. The wines were all genuine.

Proportion of
Spirit per Cent.
by Measure.

	Proportion of Spirit per Cent. by Measure.		Proportion of Spirit per Cent. by Measure.
1. Liffa	26.47	Claret Lafite	12.91
Ditto	24.35	Average	15.10
Average	25.41	27. Malmsey Madeira	16.40
2. Raifin wine	26.40	28. Lunel	15.52
Ditto	25.77	29. Sheraaz	15.52
Ditto	23.20	30. Syracufe	15.28
Average	25.12	31. Sauterne	14.22
3. Marfala	26.30	32. Burgundy	16.60
Ditto	25.05	Ditto	15.22
Average	25.09	Ditto	14.53
4. Port	25.83	Ditto	11.95
Ditto	24.29	Average	14.57
Ditto	23.71	33. Hock	14.37
Ditto	23.39	Ditto	13.00
Ditto	22.30	Ditto (old in cask)	8.88
Ditto	21.40	Average	12.08
Ditto	19.00	34. Nice	14.63
Average	22.96	35. Barfac	13.86
5. Madeira	24.42	36. Tent	13.30
Ditto	23.93	37. Champagne (still)	13.80
Ditto (Sercial)	21.40	Ditto (sparkling)	12.80
Ditto	19.24	Ditto	12.56
Average	22.27	Ditto (red)	11.30
6. Currant wine	20.55	Average	12.61
7. Sherry	19.81	38. Red hermitage	12.32
Ditto	19.83	39. Vin de grave	13.94
Ditto	18.79	Ditto	12.80
Ditto	18.25	Average	13.37
Average	19.17	40. Frontignac	12.79
8. Teneriffe	19.79	41. Cote Rotie	12.32
9. Colares	19.75	42. Gooseberry wine	11.84
10. Lacryma Christi	19.70	43. Orange wine (average of six samples made by a London manufacturer)	11.26
11. Constantia white	19.75	44. Tokay	9.88
12. Ditto red	18.92	45. Elder wine	8.79
13. Lisbon	18.94	Other fermented Liquors.	
14. Malaga kept since 1666	18.94	1. Cyder, highest average	9.87
15. Bucellas	18.49	Ditto, lowest average	5.21
16. Madeira red	22.30	2. Perry, average of four samples	7.26
Ditto	18.40	3. Mead	7.32
Average	20.35	4. Ale (Burton)	8.88
17. Cape Muschat	18.25	Ditto (Edinburgh)	6.20
18. Cape Madeira	22.94	Ditto (Dorchester)	5.56
Ditto	20.50	Average	6.87
Ditto	18.11	5. Brown stout	6.80
Average	20.51	6. London porter (average)	4.20
19. Grape wine	18.11	Ditto small beer (ditto)	1.28
20. Calcavella	19.20	7. Brandy	53.39
Ditto	18.10	8. Rum	53.68
Average	18.65	9. Gin	51.60
21. Vidonia	19.25	10. Scotch whiskey	54.32
22. Alba flora	17.26	11. Irish ditto	53.90
23. Malaga	17.26	12. Hollands (genuine)	56.00
24. White hermitage	17.43	On the Uses of Wine in a Dietetic and Medicinal Point of View.—Mankind in every stage of civilization and society betray a propensity for fermented liquors. This indeed is so strongly marked, that some have been induced to consider it as the result of an instinctive faculty, and consequently have been led to suppose that fermented liquors are the pro- per and natural drink of the human race. Others, on the contrary, have contended that fermented liquors are of no real use to mankind, and are often even productive of much positive	
25. Rouffillon	19.00		
Ditto	17.26		
Average	18.13		
26. Claret Chateau Margot	17.11		
Ditto	16.32		
Ditto Lafite	14.08		

positive evid, and hence have arrived at a conclusion diametrically opposite to the former. It is difficult to decide between these opinions. We confess, however, that we do not think it necessary, on the one hand, to have recourse to the supposition of an instinctive faculty to account for wine-drinking; nor, on the other, do we believe that the moderate use of natural wines is productive of any bad effects. The propensity for strong drinks seems explicable upon the general principle that all animals feel a pleasure in *living faster*, or, as it were, crowding a greater portion of existence into a shorter space than natural; an effect in some degree produced by the exciting effects of such liquors. As to the bad effects too frequently produced by fermented liquors, they may, in almost every instance, be fairly traced to the badness of their quality, or to an excess in quantity.

While, however, we do not object to the moderate use of what providence has so liberally bestowed upon us, no one can object more strongly than ourselves to its abuse. The melancholy effects of habitual intoxication are too well known to require particular description here. Severely do the victims of this degrading propensity suffer in mind, body, and fortune; nor are their sufferings confined to themselves, but entailed upon their ill-fated posterity. For proofs of these positions, we refer our readers to the articles GOUT, CALCULUS, APOPLEXY, EPILEPSY, INSANITY, &c. &c. in this work, where they will find these and other diseases justly ranked among the most painful and distressing to which humanity is liable, frequently ascribed to habitual intemperance as their cause.

But putting out of the question these effects of drunkenness, what a horrible picture of moral depravity does it present for a man to sit down deliberately, day after day, with the professed object of annihilating his intellectual faculties, and thus degrading himself below the vilest of the brute creation! And even supposing he has arrived at the *enviable point* of being able to swallow two or three bottles without losing his senses, and that this quantity has become necessary to his comfort, nay even perhaps to his very existence, to what a wretched state of dependence has he reduced his bloated carcase; what a tax is such a being upon society, who, to prolong a loathsome existence, is obliged to consume daily in an unnecessary superfluity more than is sufficient to support a whole family for a week! See DRUNKENNESS.

With respect to the operation of different wines upon the animal economy, they vary exceedingly according to their properties. New wines in general are unwholesome, and often prove purgative. Sweet wines are upon the whole perhaps the most wholesome, and, where the taste has not been previously vitiated, doubtless the most agreeable. Weak and acid wines are very apt to disagree with the stomach, especially when that organ has been accustomed to stronger wines. Hence an occasional debauch with such wines is notorious for inducing a fit of the gout, especially in this country, where the usual wines are immoderately strong. The same is true also, though perhaps in a somewhat less degree, with the effervescing wines. Red wines, in general, are of a more astringent and tonic nature than white wines, and commonly contain more spirit. There are, however, many exceptions to this rule.

It will be seen by consulting the above table, that port, Madeira, and sherry, the three wines in most common use in this country, contain from one-fourth to one-fifth of their bulk of alcohol. A person, therefore, who takes his bottle of wine every day, will thus take nearly half a pint of alcohol, or almost a pint of pure brandy! This at first sight will appear almost incredible, especially as the same person would not perhaps be able to take a similar quantity

of ardent spirit, either diluted with water, or in any other way. Some have concluded from this circumstance that the above experiments are not to be relied upon; but from the manner in which they were conducted there is no reason to doubt their general accuracy; the fact therefore remains to be explained. The most probable explanation is, that the alcohol in the wine is in some state of combination, which prevents its immediate action upon the stomach, and thus renders it liable to be digested or altered in its properties before it can exert its specific effects. The peculiar nature, however, of this state of combination is at present unknown. What renders this opinion the more probable is, that some bad wines, and especially domestic wines, which are often little better than mere mixtures of brandy and water, exert much more effect upon the animal economy than fine old wines, though they may not contain nearly so much spirit.

With respect to the medicinal uses of fermented liquors, when cordials are required, wines are by far the most efficient of the whole tribe, and of these *port wine* is perhaps the best. For full information on this head, we refer our readers to the articles FEVER, GANGRENE, and *Analogous Diseases of DEBILITY*. See Chaptal's excellent Essay on the Manufacture of Wines, *Annales de Chimie*, vol. xxxvi. and xxxvii. Dr. Macculloch's Essay on Wine-making. Mr. Brande's Essays in *Phil. Trans.* for 1811 and 1813, &c.

For the distillation of wines, see DISTILLATION.

WINE being a liquor mostly of foreign produce, the different names, forms, kinds, distinctions, &c. of it are borrowed from the countries where it is produced, particularly France.

Wine, in France, is distinguished, from the several degrees and steps of its preparation, into

Merre-goutte, mother-drop; which is the virgin wine, or that which runs of itself out of a tap of the vat, in which the grapes are laid, before the vintager enters to tread, or stamp, the grapes.

Must, *surmust*, or *stum*, is the wine, or liquor, in the vat, after the grapes have been trodden, or stamped.

Pressed Wine, *Vin de Pressurage*, is that squeezed with a press out of the grapes, when half-bruised by the treading. The husks left of the grapes are called *rape*, *muck*, or *marc*; by throwing water upon which, and pressing them afresh, they make a liquor for servants' use, answerable to our cyder-kin, and called *boisson*; which is also of some use in medicine, for the cure of disorders occasioned by viscid humours.

Sweet Wine, *Vin doux*, is that which has not yet worked, or fermented. This is turbid, and has an agreeable and very saccharine taste. It is very laxative, when drunk too freely, or by persons disposed to diarrhoeas, it is apt to occasion these disorders. Its consistence is somewhat less fluid than that of water, and it becomes almost of a pitchy thickness when dried.

Bouru, that which has been prevented working, by casting in cold water.

Cuve, or *worked wine*, that which has been let work in the vat, to give it a colour.

Cuit, or *boiled wine*, that which has had a boiling before it worked; and which, by these means, still retains its native sweetness.

Passe, or *strained wine*, a sort of raisin-wine, made by sleeping dry grapes in water, and letting it ferment of itself.

Wines are also distinguished with regard to their colour, into *white wine*, *red wine*, *claret wine*, *pale wine*, *rose* or *black*

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black wine. And, with regard to their country, or the soil which produces them, into *French wines, Spanish wines, Rhenish wines, Hungarian wines, Greek wines, Canary wines, &c.* And, more particularly, into *Port wine, Madeira wine, Burgundy wine, Champagne wine, Falernian wine, Tokay wine, Schiras or Sberaz wine, &c.*

Wines, again, are distinguished, with regard to their quality, into *sweet wines, rough or dry wines, and rich or luscious wines, vins de liqueur*; of which last some are exceedingly sweet, others sweet and poignant; and all chiefly used by way of a dram after meals, &c.

Such are French, *Frontignac, Madeira, the Canary, the Hungary, Tokay*, the Italian *Montefiascone*, the Persian *Schiras*, the *Malmsey wines* of Candia, Chio, Lesbos, Tenedos, and other islands of the Archipelago, which anciently belonged to the Greeks, but now to the Turks. These are sometimes called *Greek wines*, and sometimes *Turkey wines*.

The chief wines drank in Europe are as follow. 1. The Madeira island, and Palma, one of the Canaries, afford two kinds: the first called *Madeira sec*, the latter, which is the richest and best of the two, *Canary or Palm sec*. The name *sec* (corruptly written *sack*) signifies dry; those wines being made from half-dried grapes. There is another sort of *sec wine*, prepared about Xeres, in Spain, and hence called, according to our orthography, *Sheris, or Sherry*. 2. The wines of Candia and Greece are of common use in Italy. *Malmsey* was formerly the produce of those parts only, but is now brought chiefly from Spain: it is a sweet wine, of a golden or brownish-yellow colour, and to this is applied an Italian proverb, signifying, *Manna to the mouth, and balsam to the brain*. Almost all the wines used in the Venetian territories come from Greece and the Morea. 3. Italy produces the *vino Greco*, which is a gold-coloured unctuous wine, of a pungent sweetness, the growth of mount Vesuvius, but much sophisticated by the Neapolitans. In the neighbourhood of mount Vesuvius is made the *Mangiaguerra* wine, and a thick, blackish one, called *Verracia*; and at the foot of the hill the delicious *vino vergine*. The kingdom of Naples affords the *Campania or Pauslippo, Muscatel, Salernitan*, and other excellent wines, and also the *Chiarello*, much drank at Rome. But the principal is the red, fat, sweet, and grateful poignant one, called *Lachryma Christi*. 4. The Ecclesiastical State produces the bright, pleasant *Albano*, and the sweet *Montefiascone*, a yellowish not very strong wine, resembling good Florence, &c. 5. In Tuscany are the excellent white and red *Florence*; the celebrated hot, strong, red wine, *de Monte Pulciano*, &c. 6. In Lombardy, the *Modense* and *Monterrat* are tolerable; between Nizza and Savona is produced an incomparable *Muscadine*. 7. Piedmont and part of Savoy have excellent light wines. 8. The Sicilian, Sardinian, and Corsican wines are also good. 9. Most of the Spanish wines are composed of fermented or half-fermented wine mixed with inspissated must, and variously manufactured, or of an infusion of dry grapes in weak must. Of these wines, there are a few in Germany, as the *Alicant*, which is a thick, strong, very sweet, and almost nauseous wine, *Sherry, Spanish, Malmsey*, &c. 10. In Portugal there is plenty of red *Port*, which is much drank in England. The best *Vino tinto*, a blackish-red wine used by the coopers for colouring other wines, is said to be the produce of Portugal. This kingdom also deals largely in *Madeira*. 11. In France there is a great variety of wines; of which the strong, sweet, full-bodied, spirituous ones, are called *Vins de liqueur*. Languedoc and Provence afford the sweetest wines, and the same provinces, with Champagne

and Burgundy, the strongest; the wines of the northern parts, as Picardy and Bourdeaux, are the worst, and those about the middle of the kingdom, as Paris and Orleans, of a middling kind. The most celebrated of the French wines are, *Champagne, Burgundy, Vin de beaune*, or partridge-eye, *Frontinac, Hermitage*, &c. 12. In Switzerland, the best wines are, the *Neufchatel, Valteline, Lacote, and Reiff*: the *Valteline* straw-wine, so called from the grapes being laid for some time upon straw before they are pressed, is particularly celebrated. 13. The dry-grape wines of the Upper Hungary are in general excellent, and much superior to those of the Lower. (See TOKAY.) 14. Among the German wines, those of *Tyrol* are very delicate, but do not keep. 15. Of Austrian wines, those of *Kloster-Newburg* and *Brosenberg* are deemed the best: and there are also good wines in other parts of the Imperial dominions. 16. In the Palatinate, the best wine is that of *Worms*, especially the sort called *Women's Milk*. 17. Among the more esteemed German wines may be reckoned also *Rhenish, Mayne, Moselle, Neckar*, and *Elsass*: a certain writer calls the *Rhenish* made in Hockheim (Hock) the prince of the wines of Germany.

Wine is also variously denominated, according to its state, circumstances, qualities, &c. *e. g.*

Natural Wine, is such as comes from the grape, without farther mixture, or sophistication.

Brewed Wine, or Adulterated, is that in which some drug is added, to give it strength, fineness, flavour, briskness, sweetness, or some other quality which is wanted.

Pricked Wine, or Eager, is that turned sourish.

An easy method of recovering pricked wines may be learned from the following experiment:—Take a bottle of red port that is pricked, add to it half an ounce of tartarized spirit of wine; shake the liquor well together, and set it by for a few days, and it will be found very remarkably altered for the better.

This experiment depends upon the useful doctrine of acids and alkalies. All perfect wines have naturally some acidity, and when this acidity prevails too much, the wine is said to be pricked, which is truly a state of the wine tending to vinegar: but the introduction of a fine alkaline salt, such as that of tartar, imbibed by spirit of wine, has a direct power of taking off the acidity, and the spirit of wine also contributes to this, as a great preservative in general of wines. If this operation be dexterously performed, pricked wines may be absolutely recovered by it, and remain saleable for some time: and the same method may be used to malt-liquors just turned sour. Shaw's Lectures, p. 214.

Flat Wine, is that fallen weak and vapid, for want of being drank in time.

Sulphured Wine, is that put in casks in which sulphur has been burnt; in order to fit it for keeping, or for carriage by sea.

Colour, is a thick wine, of a very deep colour, serving to dye the wines that are too pale, &c. as the black wine in use among vintners. See WINE *supra*.

The method of converting white wines into red, so much practised by the modern wine-coopers, is this: put four ounces of turnsole rags into an earthen vessel, and pour upon them a pint of boiling water; cover the vessel close, and leave it to cool; strain off the liquor, which will be of a fine deep red, inclining to purple. A small proportion of this colours a large quantity of wine. This tincture might be either made in brandy, or mixed with it, or else made into a syrup, with sugar for keeping. A common way with the wine-coopers is to infuse the rags cold in wine for a night or more, and then wring them out with their hands;

but

but the inconveniency of this method is, that it gives the wine a disagreeable taste, or what is commonly called the taste of the rag, whence the wines, thus coloured, usually pass among judges, for pressed wines, which have all this taste from the canvas rags in which the lees are pressed.

The way of extracting this tincture, as here directed, is not attended with this inconveniency; but it loads the wine with water; and if made into a syrup, or mixed in brandy, it would load the wine with things not wanted, since the colour alone is required. Hence the colouring of wines has always its inconveniences. In those countries which do not afford the tinging grape, which affords a blood-red juice, wherewith the wines of France are often stained, in defect of this, the juice of elderberries is used, and sometimes log-wood is used at Oporto.

The colour, afforded by the method here proposed, gives wines the tinge of the Bourdeaux red, not the Port; whence the foreign coopers are often distressed for want of a proper colouring for red wines in bad years. This might perhaps be supplied by an extract made by boiling stick-lack in water. The skins of tinged grapes might also be used, and the matter of the turnsole procured in a solid form, not imbibed in rags. Shaw's Lectures, p. 211.

Chip Wine, is that poured on chips of beech-wood, to fine or soften it.

Rape Wine, is that put in a cask half-full of fresh grapes picked for the purpose, to recover the strength, briskness, &c. which it had lost by keeping, &c.

Burnt Wine, is that boiled up with sugar, and sometimes with a little spice.

There is also a sort of Malmsey wine made by boiling of muscadine.

Wines, Condensing of, a phrase used by Stahl, and some other writers, to express what is more usually called the concentrating of them, that is, the freeing of them from the superfluous humidity which they contain, and by these means rendering them more rich and noble, freeing them from their tasteless part, reducing them to a smaller bulk, and thus making them fitter for transportation, and finally rendering them more durable in their perfect state, and much less subject to the various accidents that make them decay. See CONCENTRATION.

Various methods have been attempted for the effecting of this, as by means of heat and evaporation, or by percolation, &c. and great objections found in the way of all of them, except the latest, brought into use by Stahl, and since recommended greatly to the world by Dr. Shaw in his Chemical Essays.

If any kind of wine, but particularly such as has never been adulterated, be, in a sufficient quantity, as that of a gallon or more, exposed to a sufficient degree of cold in frosty weather, or be put in any place where ice continues all the year, as in our ice-houses, and there suffered to freeze, the superfluous water that was originally contained in the wine will be frozen into ice, and will leave the proper and truly-essential part of the wine unfrozen, unless the degree of cold should be very intense, or the wine but weak and poor. This is the principle on which Stahl founds his whole system of condensing wine by cold.

When the frost is moderate, the experiment has no difficulty, because not above a third or fourth part of the superfluous water will be frozen in a whole night; but if the cold be very intense, the best way is, at the end of a few hours, when a tolerable quantity of ice is formed, to pour out the remaining fluid liquor and set it in another vessel to freeze again by itself.

If the vessel, that thus by degrees receives the several

parcels of the condensed wine, be suffered to stand in the cold freezing place where the operation is performed, the quantity lying thin in the pouring out, or otherwise, will be very apt to freeze anew; and if it be set in a warm place, some of this aqueous part thaws again, and so weakens the rest. The condensed wine, therefore, should be emptied in some place of moderate degree as to cold or heat, where neither the ice may dissolve, nor the vinous substance mixed among it be congealed. But the best expedient of all is to perform the operation with a large quantity of wine, or that of several gallons, where the utmost exactness, or the danger of a trifling waste, needs not be regarded.

If the wine now once concentrated should, by a long continuance in the freezing cold, be again congealed to the utmost (unless the cold were very severe indeed), and then again be drained from its ice, there, soon after this, falls to the bottom of the vessel a pure white powder or tartar, and even the icy part afterwards deposits also a little of the same substance after thawing; and after standing two or three days, there is always more and more of this tartar precipitated, and that constantly the more in proportion as the wine was more austere, or less adulterated with sugar, brandy, or the like; for these things contain no tartar.

The ice of the second operation on a quantity of wine differs in nothing from that of the first, provided only that the wine was poured clear off from it, before the ice is set to melt, by which means it dissolves into a clear phlegm. This shews the excellency of the operation; as it loses not its efficacy upon repetition, but brings away mere water as well at last as at first, without robbing the wine of any of its genuine or truly valuable parts. The remaining unfrozen liquor is a real concentrated wine, as appears by its colour, consistence, taste, and smell, and is actually become a nobler and richer wine than could have been procured without such a contrivance.

This operation, though it be perfect in regard to wine, yet does not succeed so well in regard to the malt-liquors. The experiment has been fairly tried by Stahl on a gallon of strong malt-drink, and the success was as follows:—The ice separated in the first operation, when thawed by heat, resolved into a liquor of the colour and taste of small-beer; and the second concentration afforded an ice of much the same kind, which might have passed for ordinary small-beer, but for a flashy watery taste that manifestly predominated in it. The liquor unfrozen was but a pint and a half by measure, but it was extremely rich and thick, and seemed very strong and spirituous, and perfectly aromatic, or highly flavoured. The consistence was something like that of a thin syrup, and it had a pleasing softness that sheathed the acrimony of the spirit, and covered the bitter taste of the hop.

The mucilaginous nature, which is predominant in all malt-liquors, occasions a great inaccuracy in this experiment, as not suffering the water to run clear, or be separated from the richer tincture of the malt, nor letting the condensed liquor be obtained clean from the ice; but as the loss occasioned by this is not great, and the liquor is much cheaper than wine, if this should ever come into use in the large way, the thawed liquor of the ice might be used again in a new brewing, and so the loss of that part of the strength which was carried away by the freezing be recovered.

Wines in general may by this method be reduced to any degree of vinosity or perfection. Thus, for example, if a wine of a moderate strength hath a third part of its water taken away, in form of ice, by congelation, the remaining part will thereby be doubled in strength and goodness: for if we allow, in the better sorts of wine, that one-third part, which

which is near the truth, is truly good or vinous, and two-third parts are nothing but water, one-third part of the good wine being blended among the two-third parts of water, of no strength or value; it follows, that if one of these third parts of water be taken away, and all the wine left, that which was before but one-third wine, is now one-half wine, no way reduced in its strength, and therefore the whole must be stronger in that proportion.

But if this operation of congelation be carried to the utmost, and be practised on a large quantity of wine, and with a very intense cold, and the ice taken away several times, and the wine, thus freed from a part of its water, again and again exposed, it will be found that good wines will be reduced to one-sixth part of their original quantity: and the vintner will easily find out the use of this remaining sixth part, which is a true quintessence of wine, and will be of the utmost benefit, by mixing it in small quantities with poor and low-flavoured wines, to meliorate and improve them; and even to convert the low-flavoured and least valuable ones into those very wines from which this condensed part was procured.

This method is not practicable to advantage in the wine countries alone. Dr. Shaw assures us, that he has himself experimented it here, and with the use of proper freezing mixtures has reduced wines in England to a much smaller quantity, in proportion to the whole, than in the strongest of Stahl's experiments. It is evident, that by how much the quantity is smaller, by so much it is richer and stronger, provided that the operation has been properly performed. The doctor assures us, the noble essence or rob, thus prepared, is capable of working almost miracles, by turning water into wine, and the like; but that, in order to its succeeding well, there requires great care in the operator, when the congelation is repeated the last times. Shaw's Chem. Ess. Stahl's Schematism. de Concentrat. Vin.

WINE, *Clarification of.* See CLARIFICATION, and WINE *supra.*

WINE, *Colouring of.* See WINE Colour, and WINE *supra.*

WINE, *Fining of.* See FINING, and WINE *supra.*

This operation is practised in Germany in the following manner: they have in some vaults three or four stoves, which they heat very hot: others make fires almost before every vat; by which means the must is made to ferment with great vehemence. When the ebullition, fermentation, and working cease, they let the wine stand, and then rack it. This fining is only used in cold years, when the wine happens to be green.

WINE, *Forcing of.* See FORCING.

WINE, *Domestic.* See WINE *supra.*

In the Museum Rusticum we have the following directions for making raisin wine: put thirty gallons of soft water into a vessel at least one-third bigger than sufficient to contain that quantity; and add to it one hundred weight of Malaga raisins, grossly picked from their stalks. Mix the whole well together, and cover it partly with a linen cloth. When it has stood a little while in a warm place, it will begin to ferment, and must be well stirred about twice in twenty-four hours, for twelve or fourteen days. When the sweetness is nearly gone off, and the fermentation much abated, which will be perceived by the subsiding and rest of the raisins, strain off the fluid, pressing it, first by the hand, and afterwards by a press, out of the raisins. Let this liquor be put into a sound wine-cask, well dried and warmed, adding eight pounds of Lisbon sugar, and a little yeast, and reserving part of the liquor to be added from time to time, as the decline of the fermentation will give

room. In this state, the liquor must remain for a month, with the bung-hole open; and having filled the vessel with the reserved liquor, let it be closely stopped, and kept for a year or longer, and then bottled off. At the end of a year and a half it may be drank, but will improve for four or five years.

Some saving may be made in the expence, by diminishing the quantity of raisins, and increasing that of the sugar, in the proportion of four pounds of raisins for one of sugar; or by diminishing the proportion of both raisins and sugar, and adding clean malt-spirits, when the bung of the cask is closed up. Any other large raisins may be used, as well as the Malaga; but the thinner the skins and the sweeter the pulp, the stronger will be the wine.

If this wine be perfectly fermented, and kept a long time, so that no sweetness remain, it will resemble Madeira.

An artificial Frontignac may be made of this wine, in which the proportion of sugar or of malt-spirits to the raisins is large, and the whole body weaker: the muscadel flavour being communicated by an infusion of the flowers of meadow-sweet. In the making of this artificial Frontignac, the ferment should be stopped, by closing the cask and adding the spirit, while a considerable degree of sweetness remains, and the wine may be drank after it has been a little while in the bottles.

Cyprus wine may be imitated by the same means, using three or four pounds more of sugar than the quantity above prescribed, and stopping the fermentation while a considerable degree of sweetness remains.

Artificial Mountain may be made by preserving a small degree of sweetness, giving the nut-like flavour, and keeping the best kind of the above wine to a due age. The flavour may be obtained by the infusion of the Florentine orris-root, powdered, with a very small proportion of orange and lemon peel; and the wine may be rendered more dry or sweet, by continuing the fermentation for a greater or less time, and adding a corresponding proportion of clean malt-spirits, when the fermentation is stopped sooner. The adding of some of the stony seeds of the raisins well bruised will give the nut-like flavour; and the putting in a part of the stalks will add a sharpness, found generally in this kind of wine.

The racy taste of Canary, commonly called sack, may be counterfeited by the addition of a proper quantity of the juice of white currant-berries to the wine, made with a large proportion of sugar to the raisins, and left very sweet in the fermentation. But it is said that a spirit, distilled from the leaves of clary and clean malt-spirits, put to the wine, will give it a very strong resemblance of sack. It is said also, that the juice of the bramble-berries, added to the mixture of the wine, before the fermentation, will give both the colour and flavour of claret: but in this case the quantity of raisins should be considerably diminished, and that of the sugar increased, as the fermentation must be continued till the sweetness be wholly destroyed.

Wines of this kind should be kept at least a year before they are drank. See SWEETS.

WINE, *Extemporaneous.* A hundred weight of good treacle will produce, according to the art of the distiller, from four to seven gallons of pure alcohol; that is, from eight to fourteen gallons of the common-proof melasses spirit. The still-bottoms have many uses. The distillers scald and recover their musty casks with them, and they may be used for all those purposes of cleansing where argol is required. Mr. Boyle's acid spirit of wine, or a spirit very like it, may also be procured from them, and a matter analogous

analogous to that Becher calls the *media substantia vini*. This liquor gives a durable extemporaneous wine.

WINE, *Stooming of*. See STOOMING.

WINES, *Low*, in *Distillation*, a term applied to the liquor which first comes over, when the *wash* is subjected to distillation, and which is concentrated by a second operation. See DISTILLATION.

WINES, *Medicinal* or *Medicated*, in *Pharmacy*, a term applied to those preparations, consisting of wine holding different active ingredients in solution. They were formerly very numerous, but at present their number is very limited. See VINUM, under which article those at present in use are described.

WINE, *Lees of*, are the impurities of it, or the thick sediment remaining at the bottom of the casks, when the wine is drawn out.

The distillation of wine-lees into spirit is conducted very much in the same manner with that of the malt-wash, when distilled with the mealy part in it: the principal difference is on this account, that the oil of the malt being very nauseous and disagreeable, the utmost care is to be used to keep it back in all the processes of primary distillation, and of rectification; whereas, on the other hand, the oil of the wine-lees being a very agreeable and pleasant one, as much care as possible is to be taken to bring it over with the spirit. Glauber has written a peculiar treatise on this subject, in which, without touching upon the most advantageous production of all, he has proved the work to be so very profitable, that the whole usually passes for one of his wild flights, rather than a solid business.

The method of distilling a liquid ley for its spirit is a thing universally known; but the advantageous thing, on this basis, is the distilling of a dry ley pressed and preserved, and the managing of the business in such a manner as at first or last to procure and separate all its valuable parts. The solid ley, here mentioned, is that usually sold to the hatters in England, and is the same thing that in France and other wine countries the vinegar-makers dispose of in cakes, after they have pressed out all the wine, and which was afterwards burnt, and makes what Lemery and others call *cineres clavellati*; and the English *gravelled ashes*, a fixed alkaline salt-like potash.

This ley, when used for distilling, should be that of the French wines, and either such as is newly pressed, or has been well secured by packing in a close manner in tight casks, with some proper contrivance of dry sand, or the like, to keep its external surface from the contact of the air, which is very apt to corrupt or putrefy it.

If this ley is intended to be kept many months, it will be very proper to secure it by sprinkling the layers as they are packed up with a little brandy. The expence of this is nothing, for the brandy is recovered again in the operation. Shaw.

WINE, *Oil of*, a very precious liquid, kept as a secret in the hands of some dealers in spirits, and used to give the brandy flavour to spirits of less price. It is certain that all the spirits we use take their flavour from the essential oil of the substance they are made from; that of malt is very nauseous and offensive, and renders the spirit horribly disagreeable, if not carefully kept back in the distillation of it; that of the grape, on the other hand, is extremely agreeable, and is what gives the delicious flavour to French brandy: this, therefore, is to be carefully brought over among the spirits in distillation.

This is that oil of wine so much celebrated among our distillers, and is for their use made separate, and is of such effect, that half an ounce of it will determine a pure and

clear malt spirit to be French brandy, so as to stand the test of the nicest palate, and all the trials that can be invented, provided the oil and the spirit have both been carefully made.

The manner of making the oil is this: they take some cakes of dry wine-lees, such as are used by our hatters, and dissolving them in six or eight times their weight of water, they distil the liquor with a slow fire, and separate the oil by the separating pot, reserving for this nice use only that which comes over first, the oil that follows being coarser, and more resinous. To render this business perfectly successful, there must be several things observed: 1. The ley must be of the right kind, that is, of the same nature with the French brandy proposed to be imitated. 2. The malt-spirit must be extremely pure. 3. The dose of the oil must be very well proportioned. And, 4. The whole must be artificially united into one simple and homogeneous liquor. These cautions all regard only the taste, and besides these, in order to come up to a nice counterfeit, several other particulars must be attended to; such as the colour, proof, tenacity, softness, and the like; so that, in short, the operation has too much nicety in it to be hit off by every ordinary dealer. When this fine oil of wine is procured, it may be mixed into a quintessence, with pure distilled alcohol, or the totally inflammable spirit of wine, to prevent its growing distasteful, rancid, or resinous; and thus it may be long preserved in full possession of its flavour and virtues.

The still-bottoms, or remaining matter after the distillation of this oil, will yield many productions to advantage, particularly tartar, and salt of tartar, as also an empyreumatic oil, and a volatile salt, like that of animals. Some kind of lees afford all these in much greater quantity than others; the lees of Canary and Mountain wines yield very little of them; and, indeed, scarce any tartar or fixed salt at all; but the white French lees of those thin wines that afford the ordinary brandies, yield them all very copiously, inasmuch that sometimes a single hoghead of dry and close-pressed lees will afford, by this process, three gallons of brandy, forty pounds of clean tartar, a large proportion of empyreumatic oil, and volatile salt, beside full four pounds of good salt of tartar. It is not to be expected, however, that every parcel of this ley should yield fully in this proportion. Shaw's Essay on Distillery.

WINE, *Piece of*. See PIECE.

WINE-Press, a machine contrived to squeeze the juice out of grapes, and consisting of several pieces of timber, variously disposed, which compose three bodies of timber-work, closely united to the axis, which serves as a swing, by which it may be moved by the vice. Of these there are different sizes as well as different constructions.

WINE, *Prisage of*. See PRISAGE.

WINE, *Racking of*. See RACK, and WINE *supra*.

WINE, *Spirit of*. See SPIRIT.

WINE-Spirit, a term used by our distillers, and which may seem to mean the same thing with the phrase *spirit of wine*; but they are taken in very different senses in the trade.

Spirit of wine is the name given to the common malt-spirit, when reduced to an alcohol, or totally inflammable state; but the phrase *wine-spirit* is used to express a very clean and fine spirit, of the ordinary proof-strength, and made in England from wines of foreign growth.

The way of producing it is by simple distillation; and it is never rectified any higher than common bubble-proof. The several wines of different natures, yield very different proportions of spirit; but in general the strongest yield one-fourth, the weakest in spirits one-eighth part of proof-spirit;

WINE.

spirit; that is, they contain from a sixteenth to an eighth part of their quantity of pure alcohol.

Wines that are a little four serve not at all the worse for the purposes of the distiller; they rather give a greater vinosity to the produce. This vinosity is a thing of great use in the wine-spirit, whose principal use is to mix with another that is tartarized, or with a malt-spirit, rendered alkaline by the common method of rectification. All the wine-spirits made in England, even those from the French wines, appear very greatly different from the common French brandy; and this has given our distillers a notion that there is some secret art practised in France, for giving the agreeable flavour to that spirit; but this is without foundation.

When we distil Sicilian or Spanish wines, we do not produce Sicilian or Spanish brandies; and the true reason of this is, that the wines which they distil on the spot into brandy, are very different from those which they export as wines.

Those they distil are so poor and thin, that they will not keep many months, nor can possibly bear exportation. If we had in England those poor wines they distil into brandy near Bourdeaux, Cognac, or up the Loire, there is no doubt that the spirit we made from them would be universally allowed to be French brandy. We have proof of this from some of the Scotch distilleries, where they, with no peculiar art, or secret method, procure from some of the poor pricked and damaged wines received here, brandy so nearly resembling that of France; that a good judge will scarcely be able to make the distinction. Wine-spirits and brandies, therefore, are the same thing, only with this difference, that the former is the product of a rich wine, and the latter of a poor one; or, at the utmost, they differ only as our two home products, the cyder-spirit and the crab-spirit, do.

The wine-spirit, distilled in England, is not easy to be had pure and unmixed at our distillers, nor under a price almost equal to that of French brandy; so that if it ever be required out of the trade, it is as well to use the French brandy, which will, in all cases, serve the same purposes, unless where a high flavour or a copious essential oil are required. All other spirits are carefully divested of their oil in the rectifications; but the wine-spirit is coveted only for its oil, and all that can be obtained is preserved in this, its principal use being to give a flavour to a worse spirit, and to cover the taste of a disagreeable oil in it.

When a cask of wine chances to turn sour in private hands, it is worth while to distil it for the spirit. The lees, also, if in any considerable quantity, will yield such a proportion of the same sort of spirit, as to render it worth while; and as the high flavour is not required in this intent, it will be best to draw off the spirit very gently, either by the cold or hot still, and afterwards it may be rectified without any addition, and reduced to the standard-strength of proof. It thus makes a very clean and pleasant spirit, though very different from the brandy from the same country whence the wine came. *Shaw's Essay on Distillery.* See SPIRIT.

WINE, *Philosophic Spirit of*, in the writings of some chemists and physicians, a phrase that often occurs as the name of a liquid prepared from wine, and endued with very remarkable properties.

It is generally supposed that this was the same sort of liquor, which we at this time call by the name of spirit of wine; but this is a very erroneous opinion, and has led many into errors, about the operations in which it was

concerned. It was truly no distilled liquor, but the spirituous parts of wine condensed and concentrated by the freezing of the more aqueous part.

WINE *Vinegar, Method of making of.* See VINEGAR.

WINE, *Laws relating to.*

Wine may be imported only in British-built ships, or vessels of the built of that country of which the wine is the produce, legally navigated; or in ships the built of the country in Europe under the dominion of the sovereign or state in Europe, of which the wine is the produce, or of the usual place of shipping. Penalty, forfeiture of the wine and the ship. 12 Car. II. c. 18. and 27 Geo. III. c. 19.

No other than Rhenish wine may be imported from the Netherlands or Germany, on forfeiture of ship and goods. 13 & 14 Car. II. c. 11. But wine, the produce of Hungary, may come from Hambro'; also wine, the produce of Hungary, the Austrian dominions, or any part of Germany, may come from the Austrian Netherlands, or any place subject to the emperor of Germany or house of Austria. 1 Ann. stat. 1. c. 12. and 22 Geo. III. c. 78.

Wine may not be imported in vessels under sixty tons burthen: wine and vessel forfeited. 24 Geo. III. c. 47. 26 Geo. III. c. 59. and 45 Geo. III. c. 121. Spanish and Portugal wines may not be imported in any cask containing less than a hoghead, except for private use. 18 Geo. III. c. 27. and 25 Geo. III. c. 69. French wine the same; and, except French wine in bottles, from France, Guernsey, Jersey, or Alderney. 18 Geo. III. c. 27. and 27 Geo. III. c. 13. By the 5 Ann. c. 27. a hoghead is to contain 63 gallons, or 231 cubical inches of wine. Wine (*i. e.* not Spanish nor Portugal) may not be imported in flasks, bottles, or casks, containing less than 25 gallons, except of the produce of the dominions of the grand duke of Tuscany, in open flasks, or any part of the Levant, and also wine for private use. 1 Geo. II. stat. 2. c. 17. and 25 Geo. III. c. 69. Wine may be imported in casks containing six dozen reputed quart bottles at the least. 39 & 40 Geo. III. c. 83. 42 Geo. III. c. 44. and 45 Geo. III. c. 121. Five reputed quart bottles deemed a gallon in charging duty. Wine not to be imported unless accompanied by a manifest, attested by the consul at the place of shipment. 26 Geo. III. c. 40. Wine must be entered at the custom-house and excise-office within 20 days after the ship has reported, or it may be sold for the duties, and must be removed from the quays in 10 days. 26 Geo. III. c. 59. and 35 Geo. III. c. 118. Wine landed without payment of duty is forfeited (20 Geo. III. c. 59.); but wine may be warehoused under schedule B, without payment at the time of entry of the duties due on importation, on the importer giving bond to export the same, or pay the duties within 12 months. But duty must be paid when taken out, on any excess or deficiency, from the quantity taken at the time of landing; and no wine to be warehoused in casks less than 45 gallons. 43 Geo. III. c. 132. Wine that has been warehoused may be exported, and wine that has paid duty may be shipped for drawback; but must be packed in the presence of the proper excise-officers, and the casks to be sealed with their official seals, and if they are afterwards damaged or broken, the party offending to forfeit 50*l.* for each cask or package. Due notice to be given in writing of the times of packing and shipping. 26 Geo. III. c. 59. f. 46, 47. The exporter to give bond before shipping that the same shall be exported to the place entered for, and shall not be reloaded or unshipped. To be landed in Great Britain, on forfeiture. 26 Geo. III. c. 59. f. 48.

35 Geo. III. c. 118. Wine may be exported to Douglas, in the Isle of Man, in British vessels of 50 tons, by licence of the commissioners of the customs. 52 Geo. III. c. 140.

All the duties paid upon wine shipped for the actual consumption of officers of the navy on board ship, to be drawn back according to the following proportions. 33 Geo. III. c. 48.

	Tons.
Admiral - - - - -	6
Vice-admiral - - - - -	5
Rear-admiral - - - - -	4
Captain of a first and second rate - - - - -	3
Captain of a third, fourth, and fifth rate - - - - -	2
Captain of every inferior ship - - - - -	1
Lieut. and other officer in commission - - - - -	0½

Officers of marines to be allowed half a ton *per annum*. 53 Geo. III. c. 44. But to be shipped only at the ports of London, Rochester, Dover, Dartmouth, Portsmouth, &c. Officers may remove their stock from one ship to another, and dispose of it to other officers. 38 Geo. III. c. 33.

Dealers in foreign wine to enter their premises at the excise-office, on penalty of 100*l.* for every place not entered, and forfeiture of the wine found therein. 26 Geo. III. c. 59. f. 12. Dealers to have the words 'Dealers in foreign Wines' painted over their doors, on penalty of 50*l.* sect. 15. Retailers to have the word 'Wine' exhibited in some conspicuous part of their premises, on penalty of ten shillings. 30 Geo. II. c. 19. and 32 Geo. II. c. 19. Dealers to take out a licence, to be renewed ten days before the expiration of every year, on penalty of 100*l.*; but not to apply to auctioneers selling wine by auction. 26 Geo. III. c. 59. Retailers of foreign wines, and dealers in sweets or British wines, to take out licences also; and selling them after its expiration, and before renewed, subjects them to 50*l.* penalty. 30 Geo. III. c. 18. Retailers not to sell wine in their houses, unless they have a beer licence granted by the magistrates, on penalty of 20*l.* (See *ALE-HOUSES*.) Officers may enter at any time to take an account of the stock, but if they go in the night they must be attended with a constable. The party refusing them admittance, or obstructing them, forfeits 100*l.* 26 Geo. III. c. 59. f. 17. No wine to be brought into a dealer's possession without a permit, and dealers to mark on a conspicuous part the content of each cask. 26 Geo. III. c. 59. f. 32. Any excess in dealer's stock from the account last taken, after deducting the quantity sold and entered in their books, deemed not to have paid duty, and is forfeited, and double the value. 26 Geo. III. c. 5. f. 59. 27 Geo. III. c. 31. Different kinds of wine and liquors, (cyder, spirits, &c.) to be kept separate. 26 Geo. III. c. 59. 42 Geo. III. c. 93. And no dealer in foreign wine to have any sweets or British wines in his possession. Penalty 10*s.* *per* gallon. 26 Geo. III. Account of wine daily sold to be kept, and no quantity above three gallons to be removed without permit, on forfeiture of the same, and the carriage and horles. 26 Geo. III. c. 59. 42 Geo. III. c. 95. Wine, in possession of persons *not* dealers, may have permits granted for its removal, on proving to the satisfaction of the commissioners of excise, or the collector or supervisor of the district, that the duties have been paid. 26 Geo. III. c. 59. f. 33. Permits not used to be returned to the officer, on penalty of treble the value of the wine. 26 Geo. III. c. 59. f. 37, 38; and persons forging or counterfeiting them to forfeit 500*l.* *Ibid.* sect. 39.

For the laws relating to low wines and domestic wines, see *DISTILLER*, and *SWEETS*.

WINE of Squills. See *SQUILLS*.

WINE-Measure. See *MEASURE*, and *Laws relating to WINE supra*.

WINE-Fly, in *Natural History*, the name of a small black fly, found in empty wine-casks, and about wine-lees, and called by the Latins, *Bibio*.

It is produced of a small red worm, very common in the sediment of wine.

The drippings of wine or beer vessels, the pressings of the wine or cyder press, the pots in which honey has been kept, and in which a little remains sticking to the sides, and turning sour, all afford vast numbers of a small species of worm or maggot. This is of a white colour, and has two hooks placed near the head; in short, it resembles in all the parts the maggot of the common flesh-fly. Multitudes of these small creatures live and move very briskly about in these substances for several weeks together; but at the end of that time, when they have arrived at their full growth, they enter into the nymph-state under a covering or case made of their own skin, which dries, and becomes of a brown colour. After eight or ten days in this state, the case is opened by the falling off of a small piece at the end, and the fly makes its way out. The fly is extremely small when its wings are not extended.

It does not exceed the size of the head of a middling pin; it is however very beautiful; the breast and body are yellow, the reticulated eyes are red, and the wings have all the rainbow-colours. The best way of procuring these little flies, which make a very beautiful microscope object, is to keep the matter, in which the worms are placed, in a glass, covered down with a paper; as soon as the cover is taken off, at the time of their being in the fly-state, they rise up at once in the form of a cloud; enough of them for observation will however remain about the sides of the vessel. When examined, they are found to have all the regular parts of the larger flies; their antennæ are oval and flattened, and their legs, and every other part, are as elegantly perfect, as they are seen to be in the most elegant large fly.

It is not known whether they are oviparous or viviparous; but this is to be observed, that they give us great light into the origin of animalcules in different fluids.

Since we see in these the evident course of nature in their origin, what prevents but that there may be numbers of flies yet smaller than these, whose eggs may be deposited in the fluids in which we find our microscope animalcules. Reaum. Hist. Inf. vol. ix. p. 82.

WINEBAGO, in *Geography*, a lake of North America. N. lat. 43° 50'. W. long. 87° 46'.

WINEBAGO River, a river of America, which runs from Winebago lake to Green bay into lake Michigan. The Winebago Indians inhabit near this river and lake, in about N. lat. 43° to 44°. W. long. 84° to 89°.

WINEBAGOES CASTLE, an Indian settlement in North America, near Winebago lake.

WINEE or BLACK RIVER, a river of South Carolina. See *BLACK RIVER*.

WINERSTA, a town of Sweden, in East Gothland; 18 miles N.W. of Linköping.

WING, in *Botany and Vegetable Physiology*, is generally used for any appendage to a seed, which serves to assist in its flight through the air. In this sense, the feathery crown of the Dandelion, and other syngenesious plants; the membranous expansion at the top of the scabious seed, so curiously and variously constructed in different species; the long feathery awn of the *Stipa*; and the delicate silky plumage

plumage of many seeds among the order of *Contorta*, are justly denominated wings. In a more limited and technical sense, the *Ala*, or wing, properly so called, is a thin membranous expansion, enabling the seeds to flutter to a small distance from their native capsule, rather than to fly very far. Such is found in *EMBOTHRUM*, *GREVILLEA*, *BANKSIA*, *CONCHIUM*, (see those articles,) as well as in our English genera *RHINANTHUS* and *SPERGULA*; in the latter we believe this part to vary, in degree at least. Gærtner meant to confine the term *ala* to a membranous expansion of the upper part of a seed, or seed-vessel, but he has not adhered to this intention. Winged capsules, which do not burst, are seen in the Ash and the Maple. One which does burst occurs in the curious exotic genus *BEGONIA*. The seeds of some umbelliferous plants, as *THAPSLIA*, have several wings; these are always lateral and longitudinal in that natural order; but it is far more general for them to be solitary. When the wing encompasses the seed, as in the beautiful instance of *Bignonia echinata*, figured in Gærtner, t. 52, that author properly adopts the term *ala*, and yet the expansion to which it applies is really a *margo membranaceus*, (membranous expansion,) furrounding the seed entirely, except at the very base.

The appellation of wing is given also to any membranous or leafy dilatation of a footstalk, or of the angles of a stem, branch, or flower-stalk, as well as of a calyx. The wings of a papilionaceous *corolla* are the two lateral petals, both alike, which embrace the base of the keel, and are sheltered by the standard. These spread remarkably in fine weather. They differ greatly in size and shape in different genera. See *PAPILIONACEÆ*.

WING, in *Geography*, a village of England, in Buckinghamshire, with 993 inhabitants; 7 miles N.E. of Aylesbury.—Also, a town of Sweden, in West Gothland; 40 miles E. of Gotheburg.

WING, in *Ornithology*. See *FEATHER*, and *FLYING*.

The wings are adapted for flight in all birds, except the dodo, ostriches, great auk, and the penguins, whose wings are too short for the use of flying: but in the dodo and ostrich, when extended, they serve to accelerate their motion in running; and in penguins perform the office of fins, in swimming or diving. The wings have near their end an appendage covered with four or five feathers, called the *bastard wings*: the lesser coverts are the *tetrices*: the greater coverts are those which lie beneath the former, and cover the quill-feathers and the secondaries. The quill-feathers, or *primores*, spring from the first bones of the wings, are ten in number, and broader on their inner than exterior sides: the secondaries are those that arise from the second part, or cubitus, are about eighteen in number, and equally broad on both sides. The primary and secondary wing-feathers are called *remiges*. The tertiaries are a tuft of feathers placed beyond the secondaries, near the junction of the wings with the body. This, in water-fowl, is generally longer than the secondaries, and cuneiform. The scapulars are a tuft of long feathers arising near the junction of the wings with the body, and lie along the sides of the back, but may be easily distinguished, and raised with one's finger. The inner coverts are those that clothe the under side of the wing.

The wings of some birds are instruments of offence: the anhimia of Marçgrave has two strong spines in the front of each wing; a species of plover has a single one on each; as have also the whole tribe of jacana, and the gambo, or spur-winged goose of Willughby. Pennant's *Genæsa of Birds*, pref. p. 4.

WINGS, among the *Fly-clafs*, afford several subordinate

distinctions of the genera of those animals, under the ancient general classes.

Several species of flies, while they are in a state of rest, or only walking, shew several regularly distinct manners of carrying their wings. The much greater numbers, however, carry them in a parallel or plain position: some being perpendicular to the length of the body without covering it, others covering the body without covering one another: the wings of others cross one another on the body of the animal, some of which round themselves there, the upper wing being more elevated on the middle of the body than on the sides. Some flies have their wings placed on their backs, and applied against one another, in a perpendicular position: the wings of others are applied obliquely against their sides, and meet above the body of their inner edges, forming a kind of hollow roof under which the body is placed; others form at their junction on the back a flat depressed roof, and others have them meeting under their bellies.

The structure of the wings of different flies might also furnish matter of farther distinctions. The greater part of them are of a fine structure, and represent the finest gauze, and are equally transparent, or nearly so, in all parts. Some flies, however, have wings of a less degree of transparency, and some even opaque ones. Others of the four-winged flies have obscure spots also distributed near their very transparent texture; such are the wings of the scorpion-fly; and some of the two-winged flies have wings partly opaque, partly pellucid, the opaque spots being separated by transparent lines. Reaumur's *Hist. Inf.* vol. iv. p. 136, &c.

WINGS of Butterflies. The beautiful wings of this genus of insects are distinguished from those of the fly-kind, by their not being thin and transparent, like them, but thicker and opaque. This opacity in them is owing only to the dust which comes off from them, and sticks to the fingers in handling them, and it is also to this dust that they owe all their beautiful variety of colours. The earlier naturalists, for this reason, distinguished these insects by the appellation of such as had farinaceous wings. The use of the microscope has taught us, that this dust is not the result of some other substance broken into fragments; but every particle of it is a regularly figured body, made for the place and order it has in the covering of the wing.

The several species of butterflies, and even the different parts of the same wing, afford these bodies of different shapes and figures. Most of the authors who have written of microscopic objects, have given the figures of the principal varieties of these; but no one has given so many as Bonani in his *Micrographia*, in which work the figures of the various kinds take up four quarto plates.

It has been the general custom of authors to call these feathers; but they are by M. Reaumur, with much greater justice, called scales. Their structure has no resemblance to that of feathers, for they are little flat and thin bodies, of more or less length, and always having a short pedicle which enters into the substance of the wing.

When the wing of a butterfly is viewed by a microscope, the arrangement of these several bodies in it is seen to be extremely beautiful and regular. The scales lie as regularly and evenly one over another, as the tiles on a house or the scales on the fish-kind, every series of them covering a small part of that series which runs below it. The upper and under part of the wing are equally furnished with these, and there is no species of this creature, in every wing of which there are not several figures of these scales in several parts.

The structure of the wing itself which supports these several scales, hairs, &c. is very worthy our attention. In order to examine this, it is necessary to rub off all the dust or scales. We then find that the wing itself is framed of several large and strong ribs, which all take their origin at that part where the wing is fixed to the body, and thence extend themselves along the several sides of the wing. The largest and thickest of these surrounds the outer edge of the wing, the largest next to this extends itself round the interior edge, and the others direct their course along the middle of the wing, and then divaricate, and become ramified in the manner of the ribs in the leaves of plants. The substance which connects and fills up the spaces between these ribs, is of so peculiar a nature, that it is not easy to find any name to design it by, at least there is no substance that enters the composition of the bodies of the larger animals, that is at all analogous to it: it is a white substance, transparent and friable, and seems indeed to differ in nothing from that of the large and thick ribs, but in that it is extended into thin plates; but this is saying but little toward the determining what it really is, since we are as much at a loss to know by what name to call the substance they are composed of. Malpighi, indeed, calls them bones; but though they do serve in the place of bones, rendering the wing firm and strong, without making it heavy, and are, when cut transversely, found to be hollow; yet, when strictly examined, they do not appear to have any thing of the structure of bones, but appear rather of the substance of scales, or of that sort of imperfect scales, of which the covering of those insects which we call crustaceous is composed.

The wings of butterflies, thus large, and thus light, are very well able to sustain them a long time in the air, and thus they might be expected to fly better than most other insects; but many people have observed the irregular manner in which these insects usually fly, which is not straight forward, but up and down, and to one side and the other: this has been supposed owing to some imperfection of the wings; but, in reality, it is their great perfection that enables the creatures to do this, and this manner of flying is absolutely necessary to the preservation of their life, as birds of many kinds are continually after them while they are on the wing; and it is a pleasant sight to observe in what manner this sort of dodging motion in the butterfly disappoints the bird that flies straight at it, and often preserves it safely for a long way together.

The beautiful variety of colours, seen in the wings of these insects, is owing to the scales and feathers. Reaumur's Hist. Inf. vol. i. part i. p. 255, &c.

WINGS of Gnats. These are of a very curious structure, and well worthy the use of the microscope, to see them distinctly.

It is well known that on touching the wings of butterflies, a coloured powder is left on the fingers, which, though to the naked eye it appear a mere shapeless dust, yet when examined by the microscope, it is found to be very regularly-figured beautiful bodies, encompassed with a furbelow of long feathers, and with veins or ribs that seem to strengthen them, in form of feathers or scales, or sometimes beset with prickles: these are of various figures, and all of them very elegant. The generality of flies have nothing of this kind; but the close examination of the wings of the gnat will shew, that they are not wholly destitute of them; they are much more sparingly bestowed indeed upon the gnat than on the butterfly, but then they are arranged with great regularity. Between the ribs of the wings there is extended a very thin transparent membrane, full of little

black sharp-pointed hairs, ranged throughout with the utmost regularity. The wings in different sorts of gnats are very different: some have a border of long feathers, others of short ones, and others have none at all. Reaumur's Hist. Inf. vol. iv. p. 577. Baker's Microsc. 8vo. 1743, p. 204.

WINGS, Warbling of the. See **WARBLING**.

WINGS, in Heraldry, are borne sometimes single, sometimes in pairs, in which case they are called *conjoined*; when the points are downward, they are said to be *inverted*; when up, *elevated*.

WINGS, in Gardening, &c. denote such branches of trees, or other plants, as grow up aside of each other.

Quintiny says, the term is particularly applied to artichokes, whose wings, or *ale*, are the lesser heads, or fruits, that grow up with the principal one on the same stalk.

WINGS, Ale, in the *Military Art*, are the two flanks, or extremes of an army, ranged in form of battle; being the right and left sides thereof, and including the main body.

The cavalry are always posted in the wings, *i. e.* on the flanks, on the right and left sides of each line; to cover the foot in the middle.

Pan, one of Bacchus's captains, is said to have been the first inventor of this method of ranging an army; whence, say they, it is, that the ancients painted him with horns on his head; what we call wings, being by them called *cornua*, *horns*. This at least is certain, that the method of arranging in wings is very ancient. The Romans, we know, used the term *ale*, or wings, for two bodies of men in their army; one on the right, the other on the left, consisting each of four hundred horse, and four thousand two hundred foot usually, and wholly made up of confederate troops. These were designed to cover the Roman army, as the wings of a bird cover its body.

The troops in these wings they called *alares*, and *alares copiae*; and we, at this day, distinguish our armies into the *main body*, the *right* and *left* wings.

WINGS are also used for two files, that terminate each battalion, or squadron, on the right and left. The pikes used to be ranged in the middle, and the musqueteers in the wings.

WINGS, in Fortification, denote the longer sides of horn-works, crown-works, tenailles, and the like outworks, including the ramparts and parapets, with which they are bounded on the right and left, from the gorge to their front.

These wings, or sides, are capable of being flanked, either with the body of the place, if they stand not too far distant, or with certain redoubts; or with a traverse made in the ditch.

WINGS, in a Ship, the places next the side upon the orlop, usually parted off in ships of war, that the carpenter and his crew may have free access round the ship in time of action, to plug up shot-holes, &c.

WINGS are also the skirts or extremities of a fleet, when it is ranged into a line a-breast, or when bearing away upon two sides of an angle.

It is usual also to extend the wings of a fleet in the day-time, in order to discover any enemy which may fall into their track. To prevent separation, however, they are commonly summoned to draw nearer to the centre of the squadron before night, by a signal from the commander-in-chief, which is afterwards repeated by ships in the intervals. Falconer.

WING-Transom, the uppermost transom in the stern-frame of a ship, &c., upon which the peels of the counter-timbers are rested. It is by some called the main-transom.

WINGS,

WINGS, *Goose*. See GOOSE.

WING, *St. Michael's*, is the name of a military order in Portugal, instituted, according to the Jesuit Mendo, in 1165; or, according to di Michieli, in his *Tesoro Militar. de Cavalleria*, in 1171. Its institutor was Alphonfus Henry I. king of Portugal; and the occasion was a victory gained by him over the king of Savil, and his Saracens; for which he thought himself beholden to St. Michael, whom he had chosen for his patron in the war against the infidels.

The banner they bore was a wing resembling that of the archangel, of a purple colour, encompassed with rays of gold. Their rule was that of St. Benedict; the vow they made was to defend the Christian religion, and the borders of the kingdom, and to protect orphans. Their motto, *Quis ut Deus!*

WING-Walls, of a bridge or lock, are splaying-walls for diminishing the width of the canal to such bridge or lock, and for keeping up the banks.

WINGÉ, in *Geography*, a river of France, which runs into the Demer, 2 miles W. of Arschot.

WINGED, in *Botany*, a term applied to such stems of plants as are furnished, all their length, with a sort of membranous appendage.

Several kinds of thistles have winged stalks and branches.

WINGED Leaves are such as consist of divers little leaves, ranged in the same direction, on each side of a rib or stalk, so as to appear no more than one and the same leaf. Such are the leaves of agrimony, acacia, ash, &c. See WING.

WINGED Seeds are such as have down or hairs on them, by which the wind taking hold blows them to a distance.

WINGED Stalk. See STALK.

WINGED, in *Heraldry*, is applied to a bird when its wings are of a different colour, or metal, from the body.

Winged is also applied to any thing represented with wings, though contrary to its nature; as *winged* or *flying hart*, &c.

WINGER, in *Geography*, a town of Norway, in the province of Aggerhuus; 2 miles S. of Kongswinger.

WINGHAM, a village and parish in the hundred of its own name, and lathe of St. Augustine, in the county of Kent, England, is situated 34 miles E. from Maidstone, and 62 E. by S. from London. A college of a provost and six secular canons was projected here by Kilwardby, archbishop of Canterbury, but settled and endowed by his successor, Peckham, in 1286. It was valued at 84*l.* per annum at the general suppression. By Edward VI. the college, with the patronage of the church and all tythes, were granted to sir Henry Palmer. The building, now called the college, and which formed the mansion of the Palmers, appears to have been the provost's lodge. The church contains memorials of the Palmers and the Oxendens, who have a seat at Deane, in the parish. A double row of stalls still exists in the chancel. Wingham gives a title to earl Cowper, who, however, has no estate in the parish. It gave birth to Henry de Wingham, chancellor of England, bishop of Winchester, and afterwards of London. In 1811 the inhabitants of the parish were 859, who occupied 162 houses.—*Beauties of England*, Kent, by E. W. Brayley.

WINGHAM's Island, a small island in the North Pacific ocean, near the W. coast of North America; 3 miles N.W. of Kaye's island. N. lat. 60° 4'. E. long. 215° 46'.

WINGROD, a town of Austrian Poland, in Galicia; 16 miles N.W. of Sniatyn.

WINHALL, a township of Vermont, in the county of Bennington, with 429 inhabitants; 30 miles N.E. of Bennington.

WININGEN, a town of France, in the department of the Rhine and Moselle, on the N. side of the Moselle; 5 miles W. of Coblenz.

WINKEL, a town of France, in the department of Mont Tonnerre; 14 miles W. of Mentz.

WINKELMAN, *Abbé JOHN*, in *Biography*, a German antiquary, was born at Stendal, in the Mark of Brandenburg, in 1718. Although born in very humble life, he fortunately enjoyed favourable opportunities of cultivating his talents in that department in which he afterwards attained to eminence. He had arrived at the age of 37 years before he was known to the public as an author. His first work was "Reflections on the Imitation of the Greeks in Painting and Sculpture;" and it was received in a manner that very much contributed to establish his reputation. At the court of Augustus, king of Poland, he was profelyted to the Catholic faith, more, as some have said, by arguments addressed to his worldly interest, than to his spiritual welfare. It is certain, however, that he much wished to visit Italy for the sake of examining those masterpieces of art that were to be found in that country. With this view he left Dresden, and in passing through Florence in 1756, he made a descriptive catalogue of the antiquities in the collection of the celebrated baron de Stofsch, which seemed to introduce him with advantage to Rome, whither he proceeded towards the close of this year. His acquaintance with the famous painter Mengs, Bianconi, and several other ingenious artists, forwarded his access to two of the most celebrated literary men at Rome, cardinal Passionei and the prelate Giaconelli, from whose library and learning he derived much useful information, so that he was soon acknowledged as a man of fine taste, and a distinguished connoisseur in works of art. Assuming the ecclesiastical habit, he succeeded the abbé Venuti as keeper of the pope's cabinet of antiquities; and he was also appointed copyist in the library of the Vatican. Under the patronage of the pope, who increased his income out of his privy-purse, he completed his *History of Art among the Ancients*, and then left Rome in 1768 to visit his friends in Germany, and to revise his work to be translated into French by M. Toussaint of Berlin. On his return to Rome by way of Trieste, he was assassinated, in June 1768, by a wretch who had joined him on the road, and who had so far gained his confidence, that he had shewn him some gold medals and valuable presents which he had received at Vienna. "Abbé Winkelman," says one of his biographers, "was of the middle size, with a very low forehead, a sharp nose, and black hollow eyes, which gave him rather a gloomy appearance. An ardent and impetuous disposition often hurried him into extremes. Naturally enthusiastic, he frequently indulged an extravagant imagination; but as he possessed a strong and solid judgment, he knew how to give things their just value. In consequence of this turn of mind, as well as a neglected education, he was a stranger to cautious reserve. If he was bold in his decisions as an author, he was still more so in his conversation, and often made his friends tremble for his temerity." The translation of his *History of the Arts* was completed only in part by Toussaint. Another French translation was published by Huber, professor at Leipsic. It is said that the last French translation is far preferable to the first, as it was made from an enlarged edition of the original, printed at Vienna in 1776, after a MS. left by the author. Among the other works of Winkelman were, "Letters on the Discoveries made at Herculaneum," translated into English by Mr. Gough; "Unpublished Monuments of Antiquity, such as Statues, ancient Paintings, engraved Stones, Bas-Reliefs, in Marble and

and Terra Cotta," of which there is a French translation from the Italian, Paris, 1808, 3 vols. 4to. with plates; "On Allegory, or Treatises on that Subject," 2 vols. 8vo.; and "Remarks on the Architecture of the Ancients," 8vo. Winkelman's "Letters to his Friends" were published in German, in 2 vols. 8vo., with an account of his life prefixed by Heyne. *Nouv. Dict. Hist. Gen. Biog.*

WINKOOP'S BAY, or *Wine Cooper's Bay*, in *Geography*, a large bay on the south coast of Java. S. lat. $7^{\circ} 5'$. E. long. $106^{\circ} 38'$.

WINKOOP'S *Island*, a small island near the south coast of Java. S. lat. $7^{\circ} 28'$. E. long. $106^{\circ} 36'$.

WINKOOP'S *Point*, a cape on the south coast of Java. S. lat. $7^{\circ} 25'$. E. long. $106^{\circ} 36'$.

WINLATON, a township of Durham; 6 miles W. of Newcastle.

WINNEBAGO. See WINEBAGO.

WINNENBURG, a citadel of France, in the department of the Sarre, which heretofore gave name to a lordship within the archbishopric of Treves; 1 mile N.W. of Cochem.

WINNENDEN, a town of Wurtemberg. In the year 1693, this town was laid in ashes by the French; 12 miles E.N.E. of Stuttgart. N. lat. $48^{\circ} 53'$. E. long. $9^{\circ} 30'$.

WINNICZA, a town of Poland, in the palatinate of Braclaw; 32 miles N.N.W. of Braclaw.

WINNING OF HAY, in *Agriculture*, a term sometimes applied to the operation of making hay in certain states of the weather. See HAY-Making.

WINNINGE, in *Geography*, a river of Lancashire, which runs into the Lune, 6 miles N.E. of Lancaster.

WINNINGEN, a town of Westphalia, in the principality of Halberstadt; 4 miles N. of Ascherleben.

WINNIPEG, or WINIPIC, a lake of Upper Louisiana, being the great reservoir of several large rivers, and supposed to be the largest of the inland seas, near the heads of the Mississippi, which discharges itself by the river Nelson into Hudson's bay. It is connected with other lakes to the N.W., and has, from the rivers entering into it, an inconsiderable portage to the waters of lake Superior. This lake is said to be 240 miles in length, and from 50 to 100 in breadth, though in some places it is hardly five. N. lat. $52^{\circ} 10'$. W. long. $97^{\circ} 30'$.

WINNIPEG or *Winipic River*, a large body of water, interspersed with numerous islands, causing various channels, and interruptions of portages and rapids. The lake Du Bois discharges itself at both ends of an island, on which is the carrying-place out of the lake, and which is named Portage du Rat, in N. lat. $49^{\circ} 37'$, and W. long. $94^{\circ} 25'$, about 50 paces long, and forms this river. In some parts, the river has the appearance of lakes, with steady currents: its winding course to the Dalles is estimated at 8 miles; to the Great Décharge $25\frac{1}{2}$ miles, which is a long carrying-place for the goods; from thence to the Little Décharge $1\frac{1}{2}$ mile; to the Tunejaune Portage $2\frac{1}{2}$ miles; then to its galet or rocky portage, 70 yards; $2\frac{3}{4}$ miles to the Tune Blanche, near which is a fall of from four to five feet; $3\frac{1}{2}$ miles to Portage de l'Isle, where is a trading port, and about 11 miles on the N. shore a trading establishment, which is the road, in boats, to Albany river, and from thence to Hudson's bay. There is also a communication with lake Superior, through what is called the Nipigoes country, that enters the lake Winipic above 35 leagues E. of the Grande Portage. Mackenzie's *Voyages*, &c. *Introd.* p. 60.

WINNIPEG, *Little*, a lake of North America, 80 miles long and 15 wide. N. lat. $52^{\circ} 10'$. W. long. $100^{\circ} 15'$.

WINNIPISIOGEE, or WINNIPISSIOKEE, a lake of New Hampshire; 80 miles N. of Boston. N. lat. $43^{\circ} 35'$. W. long. $71^{\circ} 18'$.

WINNOW, in *Agriculture*, signifies to fan, or separate corn from the chaff by wind.

WINNOWER, and WINNOWER-Machine. See FAN-Machine, and THRESHING-Machine.

WINNSBOROUGH, in *Geography*, a town of South Carolina; 30 miles N. of Columbia. N. lat. $34^{\circ} 28'$. W. long. $81^{\circ} 15'$.

WINNY HAY, in *Agriculture*, a term applied to hay in some conditions of it. See HAY.

WINSCHOTE, or WINSCHOTTEN, in *Geography*, a town of Holland, in the department of Groningen, near which the Spaniards were defeated by Louis, brother to the prince of Orange, on the 24th of May 1568. The Spaniards lost 2500 men, all their baggage, and six pieces of cannon. This was the first battle fought on account of the Revolution, and gave the prince a happy preface of success; 19 miles E. of Groningen.

WINSDER, a river of Norfolk, which runs into the Yare, 12 miles W.N.W. of Norwich.

WINSEN AM DER ALLER, a town of Westphalia, in the principality of Luneburg, on the^e Aller; 6 miles below Zell.

WINSEN *am der Lube*, a town of Westphalia, in the principality of Luneburg, on an island in the lake; 12 miles S.E. of Hamburg.

WINSLOW, JAMES BENIGNUS, in *Biography*, an eminent anatomist, was born in 1669 at Odenfee, in the isle of Funen, and having studied a year under Borrichius, was sent with a pension from the king of Denmark to seek improvement in the principal universities of Europe. In 1698 he became a pupil of the celebrated anatomist Duverney at Paris, and during his residence in this capital, he abjured Protestantism, and was confirmed by Bossuet, assuming in addition to his own baptismal name that of his converter, Benignus. Haller denominates Winslow "simple and superstitious," and of course his conversion to the Catholic faith afforded no great occasion for triumph. This event, however, detached him from his family and native country, and was the means of fixing his abode in France, where the patronage of Bossuet was highly favourable to his advancement, and served to obtain for him the degree of doctor in 1705. In 1707 Duverney recommended him to be an élève of anatomy in the Academy of Sciences. He afterwards read lectures of anatomy and surgery for Duverney at the royal garden; and in 1743 was promoted to the professorship in this institution. In the meanwhile, he communicated several papers on anatomical and physiological subjects to the Academy of Sciences, by which body, as well as by the Royal Society of Berlin, he was admitted into the number of associates. His great work, mentioned by Haller as superfluous all former compositions of anatomy, and entitled "Exposition Anatomique de la Structure du Corps Humain," first appeared at Paris in 1732, 4to. It was frequently reprinted, and translated into various languages; and is still regarded as of standard authority. Winslow planned, but never finished, a larger work, of which this was merely an abridgment, and he was also the author of disputations and treatises on particular topics. He died in 1760 at the advanced age of 91. Haller. *Eloy. Gen. Biog.*

WINSLOW, in *Geography*, a market-town in the county of Buckingham, England, $6\frac{1}{2}$ miles from Buckingham, and 51 N.W. from London. The market, now inconsiderable, was granted in 1235 to the abbot of St. Alban's, lord of the manor,

manor, by king Offa. The manor is now the property of William Selby, esq., who has a seat in the town. The parish-church, a spacious structure consisting of a nave, two aisles, a chancel, and a tower, contains no monuments of note. According to the population return of 1811, the houses in the parish were 223, and the inhabitants 1222. Here is a small market on Thursdays, and five annual fairs.—*Magna Britannia*, by the Rev. D. Lyfons and S. Lyfons, esq. 4to. 1806.

WINSLOW, a town of the province of Maine, on the Kennebeck, in the county of the same name, containing 658 inhabitants; 88 miles N.N.E. of Portland.

WINSTER, a small market-town in the hundred of High Peak, and county of Derby, England, is situated 5 miles W. by N. from Matlock, and 152 miles N.N.W. from London. The manor belonged to Henry de Ferrars when the Domesday-survey was taken. At a later period it was held by the Mountjoys, who were succeeded by the Meynells. The latter sold it to the freeholders in the reign of queen Elizabeth. The town affords nothing worthy of particular notice. It has a chapel of ease to the parish of Youlgrave, of which Winster forms a part; and also a chapel for the Wesleyan Methodists. A market is held on Saturdays, which appears to be by prescription; for there is no grant of it on record: till lately here was an annual fair, but it is now discontinued. The population return of the year 1811 states Winster to contain 217 houses, and 852 inhabitants; the latter are chiefly employed in the mining business, and in the inferior branches of the cotton trade. On the commons, in the vicinity of the town, are several cairns, or stone barrows, and also two or three barrows of earth: in one of the latter, which was opened in the year 1768, two glass vessels were discovered, about nine inches in height, containing a pint of water, of a light green colour, and very limpid. With these a silver collar or bracelet was found, together with some small well-wrought ornaments, several beads of glass and earth, and remains of brass clasps and hinges, with pieces of wood, that seemed to have belonged to a box in which the ornaments had been deposited. These antiquities induced Mr. King to suppose the barrow to have been raised over some Briton of distinction, though long after the Romans were in possession of the island.—*Beauties of England and Wales*, vol. iii. Derbyshire; by J. Britton and E. W. Brayley, 1803. *Lyfons' Magna Britannia*, vol. v. Derbyshire, 1817.

WINSTER, a river of the county of Lancaster, which runs into the Ken, at its mouth.

WINTBERG, a town of Prussia, on the Curisch Haff; 14 miles N. of Preckol.

WINTENAU, a town of the duchy of Stiria; 2 miles S. of Marburg.

WINTER, —, in *Biography*, a German opera composer, of great abilities, who succeeded Bianchi at our Lyric theatre in 1803; during which year he produced, in 1803-4, the music of the ballet of Achille and Deidamia, and for Mrs. Billington's benefit.

WINTER, one of the four seasons or quarters of the year.

Winter properly commences on the day when the sun's distance from the zenith of the place is the greatest, and ends on the day when its distance is at a mean between the greatest and least.

Notwithstanding the coldness of this season, it is proved, in astronomy, that the sun is really nearer to the earth in winter than in summer. The reason of the decay of heat, &c. see under HEAT.

Under the equator, the winter, as well as the other seasons,

return twice every year; but all other places have only one winter in the year; which, in the northern hemisphere, begins when the sun is in the tropic of Capricorn; and in the southern hemisphere, when in the tropic of Cancer: so that all places in the same hemisphere have their winter at the same time.

WINTER *Management of Flowers, in Gardening*, among florists, mostly consists in placing them in proper situations and exposures, in properly protecting them, in duly earthing them on the approach of the spring season, and some other matters of less consequence. Different kinds of flower-plants require different sorts of management in these respects; but in those of the primrose kind, especially in the auricula, (see AURICULA and PRIMULA,) the plants, after being placed out in proper frames, in a full southern exposure, from about the middle of October throughout the winter, and having a rather warm protection given them the whole of that time, when the weather is severe, should in all the autumnal and winter months, until the beginning of April, or later, be exposed during the day to the full open air, by wholly removing the glasses, except in the time of very heavy rains, and severe frosts or storms, though the common practice is that of keeping them on, and only letting in air by raising the lights behind. In the mid-winter season they should be kept very dry, as severe frost has in that case less effect on the roots; consequently, when rain obliges the lights to be kept on, they should be raised behind. Heavy rain, or much wet, is very prejudicial and sometimes destructive to these plants, which are otherwise hardy. Much exposure to the free air in dry weather has likewise great effect on the richness and brilliancy of their ground colours and good spring bloom, as well as on their health, vigour, and hardiness. In the afternoon, as about four o'clock, however, the plants should be covered by the lights at this season in a close manner, and have two or three thicknesses of mats thrown over them, to remain until about nine o'clock on the morning following, when, should there not be rain, hail, or snow, they may be exposed to the full open air as above; but in the contrary circumstances, the mats should only be removed so as to give light, air being plentifully let in behind. In the two beginning months of the year much must depend on the state of the weather; when mild and open, the plants may be managed nearly as above; but in severe frost and snow much more caution must be used in regard to exposure, so as not to have the mould of the pots much frozen, as the bloom is now beginning to form, and would be injured thereby; but in long frosts air should be let in as much as possible in the above manner, and light be given, with the influence of the sun, when there is any, in the middle of the day; the plants being always closely shut and covered up by three o'clock in the afternoon. Though the plants should be very dry, they should have but little water, either in rain, or from the watering-pot, in the two preceding months, and only a small quantity, or some small light southerly showers in these, so as to render the ground in a moderately moist condition. Towards the middle or end of February, the plants should be dressed, cleaned, and new-earthed with fresh mould for the spring, when there is mild open weather, removing those from the small pots into larger, and exposing them fully to the gentle rains and showers, but constantly defending them well from frosts, hail, and storms, as they now begin to shoot new fibres more quickly, and to grow fast. This manner of managing them should be continued until nearly the middle of March, after which they should be covered more warmly in the nights, for fear of frosts, and that they may be bloomed very fine.

From the middle period of the above month, and through the following, they must also be defended from frost, in order to promote the coming bloom. Great care and attention are especially necessary for blooming the plants well from the above time in March to near the end of the succeeding month, as in this time they will mostly attain their greatest perfection and beauty. It is only necessary, as it is thought, for blooming such flower-plants in the greatest perfection, to have them continually under glass, night and day, for about twenty-four of the last days, as they will then have their middle pips well expanded. In very strong sun they must be slightly shaded by a thin mat, but in other cases they may be thrown open and exposed to the full free air.

After the beginning of April, as the fifth or sixth, the glasses of the frames are to be kept completely over the plants night and day, until they are in full bloom, only letting in proper supplies of air from behind the frames, and giving the shade of old thin mats when necessary. This mode is to be pursued to about the middle of this month; but the plants are not to be over-hastened in their bloom by too much sun, as that may fade their fine colours; but in such cases they must be removed from the full southern exposure to a full eastern one, though by no means yet to a northern aspect, as that would endanger their bloom; if the season be suitable, the protection of a privet-hedge, wall, or paling-fence, is the most proper, being covered by hand-glasses; when about the end of the month, they may be removed to a northern exposure on stages, or in other proper places.

In this finishing blooming eastern exposure, all the mats and other coverings should be taken off from the glasses that are placed over the flowers, about seven o'clock in the morning, and in sunny weather the plants be shaded from about nine to twelve or one, the thin mats being then removed. The covering-glasses are to be prepared by well washing, and other means.

The flowers in blooming are mostly much benefited by having a south-west exposure as much as possible, and by carefully attending to the north and north-east winds, as well as by receiving all mild moderate rains from about the beginning of February until towards the end of March. In the latter part of this time, before the trusses are too forward, and the blossoms open, three or four hours rather heavy mild rain greatly promotes the swelling of the pips, and much increases the size of the foliage, especially if care be taken immediately after it is over to shut the flowers close down, and cover them up in a warm manner, as below. Watering them from a pot with a fine rose in a warm sunny day all over the leaves in the afternoon, in the manner of rain, and directly covering them up warmly while the sun is upon them, has likewise been found beneficial. They are now, too, to be well guarded from late frosts, as they are so soon destroyed by them.

In the late winter, or early spring, night-covering, as from the middle of the above month, the following mode has been found highly beneficial, in not only repelling the cold frosty night-air, but in assisting the bloom, and preventing its being checked in any way thereby.

The heat at this period being usually from about forty-five to fifty degrees in the day-time, the flowers may be exposed to the open air in it, and in covering them in for the night, be kept nearly to that state; which is only to be effected by an artificial covering of some sort or other, for other sorts of heat do not answer the purpose; as those of the warm blanket, horse-cloth, sheep-skin, and other similar kinds, laid next to the glasses, over which mats may be placed so as fully to protect the flowers, and keep the

other coverings from being injured by rain or other wetness. Where wood-frames and not brick ones are used, it is also often necessary to have hay, fern, straw, or some other such material, applied on the outsides of them, to guard against the penetration of the cold frosty air, as is otherwise liable to be the case in severe seasons. But such full coverings should not be had recourse to in the winter season sooner than about the middle of March, as they might not only injure the fine strong blooming plants, but counteract the good effect they are intended to have in assisting nature to gradually bloom the flowers in fine condition as the season approaches. The keeping the flowers so warm on the nights at this period of the season is supposed to prevent any check to the vegetation of the plants; and another great effect which it has is, that as soon as the pips open, they proceed vigorously, expand freely, and come out level, fine, and nearly flat; while, if they once get a complete *chill* by cold night air, their blossoms will not expand flat, but on the contrary, ruffle or furlbelow.

In the leaves of the auricula and some other kinds of plants, there is as much variety produced by these means in the shades of their green as in the colours of their flowers. The green of the leaves, or *grafs*, as it is termed, in this sort of flower-plants, should constantly be that which affords the best contrast, and has the most power in setting off the flower to which it belongs. Different varieties in the shape of the leaves also proceed from the nature of the culture and management, as well as from the raising them from seed. They have from these causes leaves with smooth even edges, with thick and fleshy edges, and with thin edges. These varieties in the leaves of such plants are often of importance to the florist in different ways. In the grafs or green leaves of these plants, there is likewise some variety in the mealy dust or farina which is upon them: in some the whole plant is nearly covered with it; but those with blueish or pea-green leaves are commonly the most powdered with this sort of dust, which contributes not only to the beauty of the plants, but serves in some degree to preserve them from the effects of the scorching heat of the sun during the summer season.

The different other fine flower-plants are to have something of the same sort of winter-management pursued for them, only making proper allowances and distinctions, in so far as their differences in the nature of their growths or other habits are concerned.

The diversities of the auricula, as well as most other flower-plants, owe their present perfection, in a great measure, to the care, ingenuity, cultivation, and management of the florist-gardener, and some of those private individuals who cultivate flowers for the amusement and delight which they afford. By these means, this and many other sorts have been wonderfully improved, which were at first single and simple; and their variety, size, and beauty, have been increased in an astonishing manner. The sportiveness of nature has likewise done much, as is evident in so many flower-plants; as in the daisy, ranunculus, the anemone, the stock, the wall-flower, the pink, the carnation, the Siberian larkspur, and a vast many more.

There is, indeed, something extraordinary in the great and uncommon diversity of the colours, and the differences of the shades and hues of this as well as some other flowers; and it is not less singular or true that out of more than an hundred flowers of this sort, which are raised from seed in this way, there will not, perhaps, be two which are exactly alike; and that yet, in all these deviations, the changes take place in the most naturally pleasing, agreeable, and unthought-of manner possible.

By attention to proper winter and other management, still more diversity and variety may most probably be produced in this and different other flowers.

WINTER, among *Printers*, that part of the printing-press, serving to sustain the carriage, &c. See PRINTING-PRESS.

WINTER's-Bark, *Cortex* WINTERI, or WINTERANUS, WINTERA *Aromatica*; which see. See CORTEX.

This is one of the largest forest-trees upon Terra del Fuego, often rising to the height of fifty feet. Dr. Solander has given an accurate botanical description of it, illustrated by a figure, in *Med. Obs. and Inq.* vol. v. p. 46, &c. Its leaves are ever-green, smooth, oval, and entire; the flowers consist of seven petals, with from fifteen to thirty stamens, and from three to six germs, terminating in as many stigmas; each germ becomes a seed-vessel, containing several seeds: the bark of the trunk of the tree is externally grey, and very little wrinkled. The pieces of this bark brought over by the Dolphin are about three or four inches square, of different degrees of thickness, from one-fourth to three-fourths of an inch. It is of a dark brown cinnamon colour, an aromatic smell if rubbed, and of a hot, pungent, spicy taste, which is lasting on the palate, though imparted slowly. A watery infusion of it struck a black colour with a solution of green vitriol. An infusion of two ounces, coarsely powdered, yielded on evaporation two drachms and twenty-four grains of extract: the same quantity, with rectified spirit, afforded two drachms of extract.

This bark, though much celebrated as an antiscorbutic by the first discoverers, is unknown in the practice of physic; the *canella alba*, (see CANELLA,) which is totally different from it, having been confounded with it in the shops; and no quantity having been brought to Europe, except as a curiosity, till the return of the ships sent out on an expedition to the South seas. It has been thought to be a useful antiscorbutic; but it seems to possess in this respect no advantage over the other pungent aromatics, and it is now generally superseded by the *canella alba*.

From some experiments on this bark by Dr. Morris, it appears to be an astringent of a particular kind, and therefore likely to be of use in several manufactures; and that water is the proper dissolvent of it.

It is hoped that this tree, no less useful than elegant, may be cultivated in our country, where it would probably grow luxuriantly, as in a much warmer region than its own, and furnish, not only a valuable ever-green, bearing our severest winters, but also a valuable medicine. *Med. Observ. ubi supra.*

WINTER-Barley, in *Agriculture*, a term applied to an excellent sort, which is put into the ground in the autumn, and which stands the winter. It is found by some farmers to be very productive in its nature, and when made into malt to form a much stronger sort than that which is produced from common barley.

In some districts, it is a good deal sown and cultivated as an early sheep-feed, in which intention it often answers very well. See BARLEY.

WINTER-Berry. See PRINOS.

WINTER-Bloom. See AZALEA.

WINTER-Cherry. See PHYSALIS *Alkekengi*.

WINTER-Cresses. See ERYSIMUM *Barbarea*.

WINTER-Crops, in *Agriculture*, a term used to signify all such as are put into the soil to grow or rise at that time of the year, which are capable of withstanding that severe season, or which can be converted to the purpose of fodder for animals at that inclement and necessitous period.

WINTER-Fallow. See FALLOW.

WINTER-Garden, a term often applied to that kind of ornamental garden which is chiefly for use and amusement at that season of the year. It has been advised by Mr. Loudon, that a winter-garden should contain all such trees, shrubs, plants, and other vegetable productions, as are in a state of perfection, or retaining their beauty and verdure, at and during this season, in the most complete manner; as most of the ever-green tribe or class of trees and shrubs, many flowering plants, as the aconite, snow-drop, Christmas-rose, and several others of similar kinds; that these should be grouped and arranged in the natural manner in such garden-grounds; and that a dry gravel or other similar kind of walk should be conducted throughout, or carried round-about the whole, in the view of being walked upon at this season without inconvenience; that these sorts of gardens should be situated near the mansion or residence, in order that they may be comfortably and conveniently approached in the different winter months; and that the conservatory too, as well as some other such houses, should be placed in them.

WINTER-Green, in *Botany*. See PYROLA.

The greater round-leaved winter-green, or *pyrola rotundifolia major*, is generally brought over from Switzerland with other vulnerary plants, in which class it is ranged, and by some greatly commended. Miller.

WINTER-Green, *Ivy-flowering*. See KALMIA.

WINTER-Green, with *Chickweed Flowers*. See TRIENTALIS.

WINTER-Heyning, in our *Statutes*, a season between the eleventh day of November, and the three-and-twentieth of April, which is excepted from the liberty of commoning in the forest of Dean, &c. Stat. 20 Car. II. cap. 3. Blount.

WINTER-Pears, in *Gardening*, such as will keep, and are ready for use in that season. It has been suggested in a paper in the second volume of the "Memoirs of the Caledonian Horticultural Society," that in the cultivation of pears of this sort, those of the *sky-bearing* sorts should be carefully avoided; that they should be suited as much as possible to the nature of the climate or region where they are to be grown; that they should have their situation in a proper exposure, and in a proper soil; that they should be well pruned, trained, and managed, in all other respects; that those kinds which can be most depended on be had recourse to; that new varieties may probably be raised from seed with advantage in this view; and that endeavours should be made to bring into use any good late sorts of this fruit.

The number of winter-pears in the northern parts of this island are supposed to be scanty indeed. That if the few that have been favourably spoken of by some cannot be had, there are not, it is believed, above five more to be depended on in these situations; which are these, the swan-egg, achon, brier-bush, the John Monteth, and to which may be added the muirfowl-egg, which keeps there much longer than the swan-egg, and must be allowed to be a winter-pear, though commonly set down as an autumn fruit. The swan-egg has there, it is said, never kept good longer than the end of November, while the muirfowl has sometimes remained in good preservation until towards the end of April. In the then last season they were taken from the tree, it is said, sooner than usual; consequently were earlier ripe or fit to eat, and of course have decayed more speedily, than ordinary. They were, however, perfectly good until towards the end of January in the following year, after which they spoiled in a very sudden manner. The muirfowl-egg

may also, however, with great safety, be allowed to remain on the tree ten or twelve days longer than the swan-egg; the leaves of the latter, too, fall, it is said, much sooner than those of the former.

On walls, in different proper aspects, the following sorts of winter-pears have, it is said, been recommended to be planted: the cressanne, the colmar, the boncretien d'hyver, the chaumontelle, and some others, which are certainly excellent pears, but that some of them are *fly*-bearers, and others do not ripen well in these parts, except in the most favourable situations. Some have found the four following sorts particularly useful on walls, especially in high situations in those northern parts of the country where the other finer sorts do not ripen in a proper manner: the green yair, muirfowl-egg, swan-egg, and winter achan. But it is noticed, that the second and the last of these sorts of pears, when planted as standards, produce not only better crops, but fruit of a higher flavour. Many other sorts are mentioned by different writers as very good winter-pears for the purpose of cultivation in these and other places; as may be seen in the above useful paper.

WINTER-Proud, in *Agriculture*, a term applied provincially to such winter-wheat, or other crop, as puts on a more green and luxuriant growth and appearance than it is able to maintain and support in the following summer season; or in which the tillering shoots, branches, or ramifications of the seed-grain, become too numerous to be nourished and brought to maturity in consequence of the previous over-exertion of the soil or land. In these cases, the crops decline during the spring and summer months, and at the harvest time yield imperfectly, falling much below the quantity afforded by such crops as had a more backward appearance in the winter season.

It is of course always of advantage to have these sorts of crops in rather a backward state in the winter period of the year.

WINTER-Quarters. See **QUARTERS**.

WINTER-Rig, among *Husbandmen*, signifies to fallow or till the land in winter.

WINTER-Solstice. See **SOLSTICE**.

WINTERA, in *Botany*, is so called in memory of the companion of sir Francis Drake, captain William Winter, who brought the bark, of the first species, from the straits of Magellan in 1579, and introduced it to the knowledge of European physicians, as a valuable tonic, more especially useful in the scurvy. Linnæus, meaning to commemorate this discovery, established a genus by the name of *Winterana*, G. Pl. 238, the bark of which he conceived to be what captain Winter introduced. But the Linnæan plant is the *Canella alba*, to the fructification of which alone the description applies. Browne had already founded this genus, by the name of **CANELLA**, (see that article,) and Swartz, as well as Murray, have confirmed it. Meanwhile Forster, having found and investigated the fructification of the Winter's-bark tree, described it by the name of *Drimys*, alluding to its hot and pungent flavour. This is retained by the younger Linnæus in his *Supplementum*, with a remark properly distinguishing it from the *Canella alba*, though his father, like prof. Bergius, *Mat. Med.* v. 1. 381, had confounded them. Finally Murray, in *Linn. Syst. Veg. ed.* 14, aware of these various errors and misconceptions, very properly establishes Browne's genus, by its right denomination, *Canella*, and restores Winter's name to the plant to which it properly belongs, and with which Linnæus intended to associate it. Murray, however, prefers *Wintera* to *Winterana*, which is the more judicious, as his genus is not really the *Winterana* of Linnæus. The name he has chosen is now,

except by an accidental mistake of De Candolle in chronology, universally adopted. Perhaps *Winteria* would have been better; but we refrain from embroiling the subject with any further alteration, of what has received the sanction of such men as Murray and Schreber.—Murr. in Linn. Syst. Veg. ed. 14. 507. Forst. Prodr. 86. Schreb. Gen. 368. Willd. Sp. Pl. v. 2. 1239. Mart. Mill. Dict. v. 4. (Drimys; Forst. Nov. Gen. t. 42. G. Forst. Nov. Act. Upf. v. 3. 181. Linn. Suppl. 43. Lamarck Illustr. t. 494. De Cand. Syst. v. 1. 442. Drymis; Juss. 280. Lamarck Dict. v. 2. 330.)—Class and order, *Polyandria Tetragynia*. Nat. Ord. *Magnolia*, Juss.

Gen. Ch. Cal. Perianth inferior, of one leaf, splitting into two or three segments. Cor. Petals six, or more, ovate, spreading. Stam. Filaments numerous, shorter than the corolla, dilated upwards; anthers terminal, of two lateral ovate cells, separate at the base, converging at their points. Pist. Germens four to eight, crowded, obovate; styles none; stigmas depressed, flat. Peric. Berries four to eight, ovate, somewhat triangular. Seeds several, disposed in two rows.

Ess. Ch. Calyx splitting unequally. Petals numerous. Stamens club-shaped, with terminal two-lobed anthers. Styles none. Berries superior, aggregate. Seeds several, in a double row.

Obf. Willdenow copies what we suspect may be a casual error of the younger Linnæus, *germina clavata*, for *flamina clavata*. De Candolle, who describes two new species, first gave a correct account of the arrangement of the seeds, an important circumstance in this natural order. His observations, confirming those of Linnæus, shew the petals to be indeterminate in number. Possibly the line is not drawn distinctly between them and the *stamens*, of which *Nymphaea* affords another instance, so that an inner series of smaller petals may occasionally occur.

1. *W. aromatica*. Official Winter's-bark. Murray n. 1. Willd. n. 1. Mart. n. 1. Forst. Pl. Magell. 24. t. 7. Comm. Goett. v. 9. 34. t. 7. Soland. in Med. Obf. and Enq. v. 5. 41. t. 1. Woodv. Med. Bot. t. 257. (Drimys Winteri; Forst. Act. Upf. v. 3. 181. Linn. Suppl. 269. Winteranus cortex; Cluf. Exot. 75. Dale Pharmac. 324. Laurifolia magellanica, cortice acri; Bauh. Pin. 461. "Periclymenum rectum, foliis laurinis, cortice aromatico acri; Sloane in Phil. Transf. v. 17. 923. t. 1. f. 1, 2.")—Leaves elliptical, obtuse, coriaceous. Flower-stalks aggregate, terminal. Pistils about four.—Native of the country on both sides of the straits of Magellan, in valleys exposed to the sun, where it was first observed by captain Winter, and has since been found by several following navigators, but no one has brought living plants or seeds to Europe. This is a tree of considerable size, often 50 feet high, with twisted knotty branches, and a thick rugged bark, of an aromatic smell, and pungent permanent flavour. This bark is not much used in practice at present, there being many drugs of equal, or superior, powers; as the *Canella alba*, which has taken its place, and caused the botanical mistake above-mentioned. (See **WINTER'S BARK**.) The leaves are alternate, crowded about the ends of the branches, ever-green, two or three inches long, and one and a half wide, thick and rigid, entire, somewhat revolute, with a stout midrib, and scarcely visible veins, very smooth on both sides; somewhat glaucous, but not invariably or permanently so, beneath. Footstalks broad and thick, smooth, half or three-quarters of an inch long. Stipules none. Flower-stalks at the ends of the branches, two or three together, simple or three-cleft, smooth, not half the length of the leaves, accompanied at their base by several ovate, pale, deciduous bractes. Flowers smaller

smaller than a hawthorn blossom, white. *Calyx* reddish, unequally three-lobed. *Berries* from three to six, each with four triangular *seeds*. By the above synonyms to this species it appears, that even G. Forster, who with his father established the genus and unexceptionable name of *Drimys*, gave way to those eminent botanists who wished to retain the memory of the original discoverer. Indeed the name of Winter may claim even a right of priority, though a mistake attended its commemoration and publication by Linnæus, in his Gen. Pl. We trust our amiable friend M. De Candolle will forgive our not joining with him, in overturning what has been finally settled, with the approbation of all the world. If chronology is to be our absolute guide, without attention to sense, or expediency, the nomenclature of botany must relapse into its pristine barbarism, and in this case Bauhin's name *Laurifolia* should have been adopted. Even on this ground, weak as it is, we can however defend the name we have retained; for Clusius's *Winteranus cortex*, erroneously printed *Cortex Winteranus* by De Candolle, may be considered as the first commemoration of captain Winter, being the first publication of any thing relating to the genus in question.

2. *W. grandensis*. New Granada Winter's-bark. Murr. n. 2. Willd. n. 2. Mart. n. 2. "Humb. et Bonpl. Pl. Æquinox. v. 1. 205. t. 58. Lozano in Sem. Nov. Gran. for 1809, 180." (*Drimys grandensis*; Linn. Suppl. 269. De Cand. n. 3.)—Leaves elliptic-lanceolate, obtuse. Flower-stalks axillary, solitary. Pistils eight.—Sent by Mutis from New Granada. It grows on the most lofty mountains of that country, Quito, &c. The tree is 18 or 20 feet high, with round branches, more straight, and less rugged, than the foregoing. *Leaves* four or five inches long, and near one inch and a half broad, obtuse, not acute, scarcely revolute, perfectly smooth; very glaucous beneath, like those of *Magnolia glauca*, the longer-leaved variety of which they greatly resemble. *Footstalks* smooth, an inch long. *Flower-stalks* sometimes nearly the length of the leaves, always half as long, simple, divided, or three-cleft. *Flowers* twice the size of *W. aromatica*, with about 12 petals, and a deeply three-cleft calyx. *Berries* six or eight, obovate, sometimes confluent, each with from four to six seeds. The bark is aromatic, like the former. The younger Linnæus imagined this to be a variety of that species, caused by a warmer climate. They are indeed more nearly related than appears at first sight, and yet we can scarcely think they belong to one species, though well aware that the leaves, in this natural order, are liable to vary considerably in shape; witness the *Magnolia* just mentioned, if more than one species be not confounded under that name.

3. *W. chilensis*. Chili Winter's-bark. (*Drimys chilensis*; De Cand. n. 4.)—Leaves oblong-obovate; glaucous beneath. Flower-stalks either aggregate or compound, axillary. Pistils five or six.—Gathered by Dombey, in marshy situations in Chili. A tall shrub, with a very aromatic bark, and round branches. *Leaves* nearly obovate, coriaceous, very smooth, tapering at the base, on short stalks, resembling the foliage of *Magnolia glauca*. *Flower-stalks* axillary; sometimes very short, bearing an umbel of four or five elongated simple stalks; sometimes four or five simple ones all together, each an inch long at most, single-flowered. *Calyx* in two or three ovate blunt divisions, not soon deciduous, and perhaps lasting till the fruit is ripe. *Petals* fix to nine, oblong, bluntish, twice the length of the calyx. *Stamens* very short. *Germens* five or six, ovate, crowded, on a small globose receptacle. *Berries* oval, rather compressed, obtuse. De Candolle.

4. *W. mexicana*. Mexican Winter's-bark. (*Drimys mexicana*; De Cand. n. 5. "Moq. et Seffé Pl. Mex. ined. t. . .")—Leaves oblong-lanceolate, pointed at each end. Flower-stalks elongated, umbellate, four-flowered. Petals twenty to twenty-four, acute. Germens four.—Native of Mexico. A shrub, with round branches, terminating in a sharp bud, as in the *Magnolia*. *Leaves* stalked, tapering at each end. *Common flower-stalks* an inch, or an inch and a half long, divided at the top into an umbel of four long, single-flowered, *partial stalks*. *Calyx* divided, permanent, concave. *Petals* white, spreading, oblong, in a double row. *Stamens* very short. *Berries* four, or, from occasional abortion, only two or three, obovate, tapering at the base, of a blueish-violet colour. De Candolle from a coloured drawing.

5. *W. axillaris*. Small-flowered Winter's-bark. Forst. Prodr. 42. Willd. n. 3. Mart. n. 3. (*Drimys axillaris*; Linn. Suppl. 270. Forst. Act. Upf. v. 3. 182. De Cand. n. 1. Lamarck f. 2, copied from Forst. Nov. Gen. t. 42. f. a—l.)—Leaves obovate, pointed, reticulated with veins. Flower-stalks simple, aggregate, thread-shaped. *Calyx* orbicular, lobed, reflexed.—Native of woods in New Zealand. A tree, with round branches, rough to the touch, but not warty. *Leaves* on stalks rather above half an inch long, broadly obovate, tapering to a bluntish point, smooth, more thin and membranous than in any of the other species, copiously reticulated with innumerable veins, not observable in any of those; their length three or four inches, breadth two; their under side glaucous when young only. *Flower-stalks* two or three together, seldom solitary, from the bosoms of most of the leaves, simple, very slender, each bearing a small green flower. *Calyx* discoid, soon reflexed, about a line broad, splitting into two principal, and two smaller, lobes, not differing in any particular respect from the divisions of the calyx of the other species, though Forster's figure has misled De Candolle to suppose otherwise. *Petals* six, oblong, flat, equal, four times the length of the calyx. *Stamens* about sixteen. *Germens* four, turbinate, all perfectly and evidently distinct, in the numerous flowers of the Linnæan specimen; so that Forster might well wonder how the younger Linnæus, who had this very specimen before him, could make a "solitary pistil" a part of the specific character. *Stigmas* dilated, peltate, terminal. *Berries* four, globose, black, with a tawny pulp, lodging four ovate, acute, somewhat triangular, gibbous seeds. The flavour of the whole plant, especially of the bark, is extremely acrid and pungent. G. Forster.

WINTERANA. See CANELLA, and WINTERA supra.

WINTERBERG, in Geography, a town of the duchy of Westphalia; 37 miles S. of Paderborn. N. lat. 51° 11'. E. long. 8° 39'.

WINTERBERG, or Winberg, a town of Bohemia, in the circle of Prachatitz; 10 miles W. of Prachatitz. N. lat. 49° 2'. E. long. 13° 39'.

WINTERBURG, a town of France, in the department of the Rhine and Moselle; 10 miles W.N.W. of Creutznach.

WINTERHAM, a place in Virginia, where black-lead is found; 30 miles N. of Richmond.

WINTERHAUSEN, a town of the duchy of Wurzburg, on the Maine; 4 miles S. of Wurzburg.

WINTERINGHAM, a town of England, in the county of Lincoln; 166 miles N. of London.

WINTERTHUR, a town of Switzerland, in the canton of Zurich. This was formerly an imperial town. In the year 1467, it was mortgaged to the canton of Zurich, and by subsequent treaties entirely ceded, since which Winterthur

thur has acknowledged Zurich for its sovereign. It is governed, however, by a magistracy and police of its own. The government is aristocratical; the supreme power, in all things not interfering with the claims of Zurich, residing in the Great and Little council, in all criminal proceedings these two tribunals unite, and pass sentence of death without appeal. In civil causes, an appeal lies from the Little to the Great council. In all cases respecting the burghers, appeals may be carried from the town-court to the council of magistracy, and no farther; but if either of the parties be a foreigner, an appeal lies from the council to the senate of Zurich. A bailiff from this latter place likewise resides here, but without any authority over the town, excepting that of assisting at the ceremony of an annual homage paid to Zurich by the burghers on St. Alban's day. In case of a war, Winterthur furnishes Zurich with 200 men, either burghers or dependents, but to serve under its own colours. Except in the articles of silk manufacture, and the establishment of a printing-press so profitable to Zurich, the commerce of Winterthur is under no restraint. The principal manufactures are, muslin, printed cottons, and cloth: it has some vitriol works; and the earthen-ware made here, particularly the white, together with its painted stoves, are in great repute for their beauty and durability. The town is small, and the inhabitants, who are about 2000, are very industrious. The schools are well endowed and regulated. Ober Winterthur, or Upper Winterthur, is a small village near the town, on the high road leading to Frauenfeld, on the site of the ancient Vitodurum, which was a Roman station. Here are found the foundations of ancient walls and numerous Roman coins and medals. The castle of Kyburgh, seated on an eminence overlooking Winterthur, is a picturesque object; 14 miles N.E. of Zurich.

WINTERTON, a town of England, in Lincolnshire; 9 miles N.N.W. of Glanford Brigs.—Also, a town of England, in the county of Norfolk, near the coast. The market is discontinued; 7 miles N. of Yarmouth.

WINTERTON *Nefs*, a cape on the E. coast of the county of Norfolk, on which is a light-house; 10 miles N. of Yarmouth. N. lat. $52^{\circ} 44'$. E. long. $1^{\circ} 41'$.

WINTFELDEN, a town of France, in the department of the Upper Rhine; 10 miles S.W. of Colmar.

WINTHAG, a town of Austria; 6 miles N.E. of Freystadt.

WINTHROP, a post-town of the province of Maine, in the county of Kennebeck, with 1444 inhabitants; 57 miles N. of Portland.

WINTHROP'S Bay, a bay on the N. coast of Antigua.

WINTON, a county of United America, in the state of South Carolina.—Also, a post-town of North Carolina; 30 miles E. of Halifax.

WINTONLÆ ROTULUS. See ROTULUS.

WINTZENBERG, in *Geography*, a town of Silesia, in the principality of Neisse; 5 miles S.E. of Grotkau.

WINTZENHEIM, a town of France, in the department of the Upper Rhine; 3 miles W. of Colmar.

WINTZIG, a town of Silesia, in the principality of Wohlau; 9 miles E.N.E. of Steinau. N. lat. $51^{\circ} 27'$. E. long. $16^{\circ} 36'$.

WINWEÏLEK, a town of France, in the department of Mont Tonnerre; 24 miles N.E. of Deux Ponts.

WINWOOD, Sir RALPH, in *Biography*, a statesman in the reign of James I., was born at Aynho in Northamptonshire, about the year 1564, educated at St. John's college, Oxford, and having passed through several stages of preferment, was chosen professor of the university in 1592. After having sustained several diplomatic characters and missions,

he was made secretary of state in 1614, which office he occupied till his death in 1617. "He was married, and left one son. Sir Ralph was an accomplished gentleman, well acquainted with business, and particularly conversant with commercial and military affairs." A work, intitled "Memorials of Affairs of State in the Reign of Queen Elizabeth and King James I., collected chiefly from the Original Papers of the Right Honourable Sir Ralph Winwood, Knt. &c. &c." was published in 1725 by Edmund Sawyer, esq. in 3 vols. fol., and contained a valuable record of the political transactions of those times. Biog. Brit.

WINYAH, in *Geography*, a county of South Carolina.

WINZAH HARBOUR, a bay on the coast of South Carolina, a little to the N. of the mouth of the Santee. N. lat. $33^{\circ} 12'$.

WINZER, a town of Bavaria, on the Danube; 9 miles S.S.E. of Deckendorf.

WIOCHIST, among the *Indian Natives of Virginia*, is their priest, who is also generally their physician; and is the person in the greatest honour amongst them, next to their king, or great war-captain. Phil. Transf. N^o 454. sect. 1.

WIOGRODEK, in *Geography*, a town of Poland, in Volhynia; 14 miles E.S.E. of Kreminek.

WIP, a town of Prussia, on the Curisch Haff; 23 miles S.W. of Tilsit.

WIPACH, a town of the duchy of Carniola; 5 miles S. of Hydria.

WIPE, a town of Prussia, in the province of Smaland; 28 miles N.E. of Königsberg.—Also, a river of Prussia, which runs into the Curisch Haff, 10 miles E.N.E. of Labiau.

WIPFELN, a town of the duchy of Wurzburg; 5 miles N.N.W. of Volkach.

WIPPELSPACH, a town of the duchy of Stiria; 17 miles S.W. of Voitsberg.

WIPPER, a river of Germany, which rises in the county of Mark, about 6 miles S.S.W. of Lunschede, passes by Wipperfurt, Elberfeld, Solingen, &c. and runs into the Rhine, between Cologn and Zons.—Also, a river of Thuringia, which rises 2 miles N. of Dingelstadt, and runs into the Unstrutt, 4 miles N.E. of Kindelbrucken.—Also, a river of Pomerania, which runs into the Baltic below Rugerwalde.—Also, a river of Saxony, which runs into the Saal, near Bernberg.

WIPPERAU, a river of Westphalia, which runs into the Ilmenau, near Ultzen.

WIPPERFURT, a town of the duchy of Berg; 27 miles S.E. of Duffeldorf. N. lat. $51^{\circ} 5'$. E. long. $7^{\circ} 27'$.

WIPPINGEN, a town of Switzerland, in the canton of Friburg; 12 miles S.S.W. of Friburg.

WIPRA, a town of Westphalia, in the county of Mansfeld, on the Wipper; 10 miles W.N.W. of Eifzleben. N. lat. $51^{\circ} 30'$. E. long. $11^{\circ} 30'$.

WIRBEN, a town of Westphalia, late in the Old Mark of Brandenburg, on the left side of the Elbe; 12 miles N. of Stendal.

WIRBENTHAL. See WURBENTHAL.

WIRDOIS, a town of Sweden, in North Finland; 65 miles N.N.E. of Biorneborg.

WIRE, in the *Mechanic Arts*, is a very useful preparation of different metals, in form of a regular and even thread, which can be obtained in very great lengths, and of any required size or shape.

Wire is made of any ductile metal, as platina, gold, silver, copper, brass, zinc, iron, or steel. The process of making wire

wire consists in drawing the piece of metal through a hole in a plate of steel, by which means the metal is rendered of an equal size, and either round or of any other figure corresponding with the figure of the hole in the draw-plate; the metal is thus reduced in size, and at the same time is lengthened in proportion. From the great regularity of wire, and from its toughness and ductility, it is extremely useful to all artists who work in metal.

The operation is called wire-drawing, and the plate of steel a draw-plate. The machine by which the wire is drawn is called a draw-bench.

The common draw-bench is of a simple structure. A strong plank of wood is fixed on legs, like a stool or bench, *fig. 1. Plate Wire.* At one end is a roller or axis, *A*, fixed in an horizontal position, so that it can be turned round by means of four levers, *B B*, fixed like radii on the end of the axis of the roller. If the resistance is great, the workman applies both his hands and his feet to the levers, to turn them round in the same manner as for a rolling-press. It is usual to have a strong strap, or chain, *C*, to wrap and wind up round the roller; and at the end of it a pair of pincers, *D*, are linked: these take hold of the end of the piece of metal, and draw it through the hole in the draw-plate *E*, which is lodged against two strong iron pins, *aa*, fixed in the bench, and standing up perpendicularly, so that the plate bears against them.

The pincers are shewn in *fig. 2.* They are adapted to bite the end of the wire; and the inside of the jaws, *dd*, are cut with teeth like a file, that they may hold the metal very tight. The opposite ends of the handles are bent in form of hooks at *ee*; and a triangular link of iron *f*, which is fastened to the end of the strap or chain *C*, embraces both hooks *ee*, and from its triangular figure, it tends to approach the two hooks at the ends of the tongs together: by these means, the strain of drawing the wire closes the pincers, and makes them bite more forcibly in proportion as the wire makes a greater resistance, so that they rarely let the wire slip.

The draw-plate, *figs. 3 and 4*, is a thick plate of steel, with holes made through it of various sizes, and in a regular gradation from the largest to the smallest. The holes are made large on that side where the wire enters, and they diminish with a regular taper to the other side; the goodness of the draw-plate is an object of the first importance. The different holes must diminish by very small gradations, or there will be danger of breaking the wire by forcing it too much at once.

In some draw-benches a rack and pinion are employed, instead of a strap or chain; and a train of wheel-work may be used like that of a crane to obtain a sufficient power. (See *fig. 5.*) If the workman turns the machine by a winch or handle, it is preferable to four levers, because the motion is more regular; this is of importance for some purposes. Suppose a piece of elastic metal is forcibly drawn through a hole in a plate with a tolerably quick motion, it will be compressed at the moment of passing through the hole; but after it quits the hole, the metal will expand a little. When it is drawn very slowly, this effect will not take place; for if the compression is continued long enough it becomes permanent: hence, if a piece of large wire be drawn with an irregular motion, first quicker, and then slower, it will be sensibly larger at all the parts which pass quickly through the hole, and smaller where it is drawn slowly: if the motion is suspended for a few seconds, that part of the wire which remains in the hole will have a ring or indentation round it. This is most obvious in drawing hollow tubes, or copper-wire, which is plated over with gold or silver.

In the machine which is used for drawing strong pieces

of metal, and for the very largest, the roller is usually placed in a vertical position, like a capstan, with four levers, at which several men push, whilst they walk round in a circle to turn the capstan, and wind up the chain which draws the wire through the draw-plate.

A powerful machine of this kind is described in our article *PIPES*, for drawing lead-pipe through a steel plate.

We have seen a very powerful wire-drawing machine used for forming large hollow tubes of brass or copper, on which the power to draw the tube was obtained by a screw, like that of a press. This screw was turned by a train of wheel-work, with a fly-wheel to regulate the motion.

Another plan, which is perhaps the best mode for a very powerful drawing-machine, is to apply the force of the hydrostatic machine originally invented by Pascal, and revived by the late Mr. Bramah. (See *MACHINE*, and *PRESS.*) By this means, very large wires for piston-rods of steam-engines, and other similar pieces, may be rendered straight and true with little expence.

All these machines are confined to draw pieces of metal, which are only a few feet in length, that is, the length of the bench. But when the metal by repeated drawing becomes lengthened into a regular wire, if it is required to reduce it to a still smaller size, it must be drawn through succeeding plates, by wrapping the wire itself upon the roller or barrel, instead of employing a long chain. This method is not applicable at first, because a thick bar of iron could not be made to bend easily round a roller; but when the wire becomes small and flexible, it can be practised very advantageously, and admits of drawing a very great length of wire by a small and commodious machine.

The common wire-mills used in France do not, however, employ a roller or windlafs, but the pincers are attached to a lever, which draws them backwards and forwards alternately by the power of the water-wheel.

The pincers are so constructed, that the jaws open when they move towards the draw-plate, and release themselves from the wire; but when the pincers are drawn back from the draw-plate, the link causes the pincers to close and bite the wire with such force, that they will draw it through the plate.

A machine of this kind is shewn in *fig. 7.* of the plate. The base of the machine is a very strong log of timber *R*; one end of it is cut open to receive a wooden lever *A B*, which moves round an iron pin or bolt *n*, as a centre of motion; this lever is shaped like the letter *L*. To the upright arm *A* of this lever, an iron link *C* is jointed, and the other end of this link is formed like a ring, to receive the handles of the pincers *D*. The pincers are supported upon a plate of iron *d*, which is placed in an inclined position, and there is a groove in the plate, into which the end of the pin or joint of the pincers is received, and they are by that means guided in their motion backwards and forwards: *aa* are the pins which support the draw-plate *E*; there are four of them, and the plate is fastened between them by wedges.

The end *B* of the lever is operated upon by cogs fixed on the axis of the water-wheel, which, as it turns round, depresses the end *B* of the lever; and the end *A* pulls the pincers back, and draws the wire through the draw-plate; but when the cogs quit the end of the lever, it is returned by means of a rope fastened to the end of *B*, and going up to a strong wooden pole fixed on the roof of the building; and it acts as a spring. When the pincers return, they open to release the wire, and slide down the inclined plate *d* by their own weight, till they are near the draw-plate; the wire being all the time included between the jaws, though they

they do not bite. The next cog which seizes the end of the lever draws back the pincers, which immediately close upon the wire, and draw it through the plate.

A wire-mill usually contains three such machines of different sizes: the largest only draws two inches of the wire at each stroke, and makes about forty-eight strokes in a minute; the second machine, four inches; and the third, five inches. This works quicker than the other two, and makes sixty-four strokes *per* minute. This is a simple machine, but very defective, for much time is lost in the returning of the pincers; they sometimes fail to take good hold of the wire, and they always make deep marks upon the wire at every place where they bite, which are not more than two inches distance in the great wire, and five inches in the smaller.

Fine wire is always made from large wire, by reducing it and lengthening it out by repeated drawings. The large wire is usually manufactured at the wire-mills in the country, and some part of it is reduced to small wire at the same establishments, but more commonly the large wire is bought by those who have occasion for it, and they reduce it by drawing until it becomes as small as it is wanted.

The hand-machine for this purpose, represented in *fig. 8*, is extremely simple. *A* is the roller on which the wire is wound up; it turns round upon a vertical pin, fixed in the bench *R*, and to the upper end a handle *B* is fixed, for the workman to turn it round; *E* is the draw-plate, and *a a* the pins against which it rests. The wire which is to be drawn is put upon a small circular reel *F*, which turns round upon a vertical pin; this pin is sometimes fixed in the table, or otherwise in a small cask containing starch-water, or beer which has become acid. The use of this is to loosen the oxyd from the surface of the wire, for it is necessary to anneal or soften the wire very frequently, by putting it in the fire, and this produces a black coat of oxyd on the surface, which will be removed when the wire is again drawn through the plate, and the wire will come out bright and clean. The removal of this oxyd will be facilitated by some slightly corrosive menstruum.

Fig. 9. is a very simple and complete wire-drawing machine, to draw three wires at once. *A R* are two rollers or barrels with cog-wheels, *T V*, on the ends of their axis, which wheels are engaged together. *S* is a pinion, which is turned round by means of a handle *B*, and gives motion to the wheels *T V*. Both these wheels are fitted upon round parts of the axis of their respective rollers, so as to slip or turn freely round upon the same; but a square is formed on the axis outside of the wheel, and a clutch or catch, *t* or *v*, is fitted on this square part, so as to turn always round with the axis. The catch is at liberty to slide upon the axis in the direction of its length, by means of a lever *W*, which operates upon both catches at once. When either of them is pushed back in contact with the wheel, it intercepts two studs which project from the face of the wheel, and then compels the axis and roller to turn round with the wheel; but when the catch is drawn away from the wheel, then the wheel will flap round upon its axis, without communicating any motion. By means of the lever *W*, only one wheel can be engaged at once, and the other must be free. The draw-plate *E* is firmly fixed between the two rollers, and it has a great many holes; the rollers are long enough to receive three wires at the same time. Each roller has a groove in it parallel to the axis, into which a bar of metal is fitted, and will exactly fill it up. When the wires are introduced through the holes in the plate, the ends are laid across this groove; the bar is then put in and fastened by a simple contrivance, and it

fastens the ends of the wires beneath it, so that they become attached to the roller; then by turning the handle *B* round, the two wheels are put in motion in contrary directions; and that wheel which is connected with its axle by its catch, will turn its barrel round, and wind up the wires so as to draw them through the plate *E*. The other roller being at the same time detached, its wheel is at liberty to turn round in a contrary direction to the wheel, as fast as the wires are drawn off from it. When the whole length of the wires has been drawn through the plate, they are detached from the roller, the ends introduced through smaller holes in the plate, and fastened again to the roller; then the lever *W* is shifted, to disengage that wheel which operated before, and engage the other. This being done, the rollers will be turned in an opposite direction, and will wind back the wires, although the handle *B* is turned the same way round.

After the wire has been then drawn three or four times, the metal becomes so hard and fibrous, that it would not draw any more without breaking; it therefore requires to be heated in the fire to restore its ductility; for this purpose it must be taken off the barrels. A roller *M* is provided to wind the wire upon and draw it off from the barrel; this roller is turned round by a handle *m*, fixed on the extremity of its axis; and the wire which is wound upon it in a coil is slipped off sideways. This machine is well adapted to be worked by a mill, because the handle may always be turned the same way.

Fig. 10. represents the machine used at the wire-mills for reducing the wire which is to be used for musical instruments, or for making cards for wool and cotton. The rollers *A* are situated in a vertical position, being fitted on the tops of iron spindles, which are sustained in a vertical position by bearings in the frame of the table or bench. These spindles are kept in continual motion by wheel-work situated beneath the bench, but the spindles are round, so that the rollers *A* are not turned with the spindles, unless any one of the rollers is lifted up upon the spindle. A cross-bar, which is fixed on the top of the spindle, then engages with two projecting knobs fixed in the roller, within a hollow recess made at the top of it, and turns the roller round. The draw-plate *E* is supported by two pins, as before described; and the wire which is to be drawn is wound on a reel, which is put into a cask of stale-beer grounds, or starch-water. The end of the wire, which is put through the draw-plate, is made fast to the roller, which does not turn round as long as it is dropped down upon the spindle; but when all is ready to begin drawing, the roller must be lifted up, and the clutch at the top of the spindle will engage with the two knobs within the hollow at the top of the roller. This puts it in motion, and draws the wire through the draw-plate. The strain of drawing is sufficient to keep the roller up upon the spindle; but as soon as the whole of the wire is drawn through the plate, the resistance ceases, and the roller drops down on its spindle, and becomes disengaged until the workman puts it again in action.

Manufacture of Iron Wire.—Iron is a very ductile metal, but requires a careful treatment in the process of wire-drawing, because it becomes very hard and brittle when the fibres are greatly compressed by repeated drawing. Its ductility must then be restored by heating the wire to redness; this is called annealing: it renders the wire soft, and it will then draw finer and longer; but it will soon require annealing again, and so on.

The iron which is selected for wire-drawing must be of good quality, to bear the requisite extension without breaking. It must be of an uniform substance, without any grains

of hard or soft parts. The softest iron is not always found the best, as it will diminish by the strain of drawing it through the holes alone: and to obviate this, the workman must draw such iron through a greater number of holes to obtain the required extension.

The iron is wrought at the tilt-mills from square bars into round rods of a proper size to commence drawing. The operation of tilting is nearly the same as *tilting of steel*. (See that article.) The tilt-hammer for a wire-work generally makes twenty strokes *per* minute, and weighs about fifty pounds. There is also a larger hammer worked by the same mill, which strikes about 130 times *per* minute, and weighs 100 pounds. This hammer is only used for the first preparation of the iron, or for welding a faggot of small bars together, in order to give the iron a better quality by a preparation similar to the German steel. To draw out the iron bars into rods of a proper size to begin drawing, the workman heats six or eight inches of the end of a large bar, which comes from the great forge where the iron is made, and when properly heated he works it regularly under the small tilt, until it is drawn out to a small and regular round rod of five or six feet in length. A good workman can thus draw out two hundred weight of iron in a day, or an ordinary workman one and a half hundred weight. The loss of metal in the operation is near 6 *per cent.* by weight.

The small rod, before it is cold, is taken by another workman, who straightens the rod with a hammer upon an anvil, then cuts it off, and places the end of the great bar again in the forge. This same workman also superintends the heating of the iron, and must be very careful not to overheat it, but to heat the whole regularly.

It is a good practice to pass the iron-rod through a pair of grooved rollers, the grooves of the two rollers being opposite, so as to form a round between them. By these means, the iron may be reduced small, and rendered very true, previously to beginning the drawing. For common wire, the whole reduction may be done by the rolling-mill without a tilt; but the hammer will give a more tenacious quality to the iron than can be obtained by rolling.

A small round bar, thus prepared, must be drawn through a hole in a draw-plate, by a strong machine with a chain, or else by the lever-machine, *fig.* 7. The end of the iron is first reduced, so that it will enter the hole in the draw-plate, and pass through sufficiently for the pincers to take hold. This is done at the forge by a hammer and anvil. By passing through the plate the wire becomes lengthened, in proportion as it is diminished in size. It must then be annealed to soften it, the end pointed anew, and again put through a smaller hole.

The workman who attends the process must study the nature of the iron, and regulate the manner of drawing accordingly. This he does by altering the figure of the hole through which the wire is drawn. The hole must be conical; the smallest part, being that which acts principally on the metal, must be at that side of the plate where the wire comes through. If the taper of the hole is not properly proportioned, the iron will be strained in drawing; for though the machine will force it through, grains of harder metal than the rest of the wire will form themselves, which will occasion the wire to break when it comes to be much reduced. This is particularly the case in soft iron. To avoid this, the hole must be chosen very little smaller than the iron, and must be made with a regular taper. It must be well supplied with grease, to diminish as much as possible the friction; and the motion of the draught must be regulated according as the metal will bear it.

Much depends upon the quality of the draw-plate; although the metal of the plate is sufficiently hard to draw the wire, it will not resist the blow of a hard steel hammer and punch. The punch is driven into the hole from behind, until it enlarges it to the required size and figure. In the operation of drawing, the hole becomes gradually enlarged, and that in a greater degree at the smallest end of the hole, so that it becomes nearer to a cylinder. To rectify this, the punch must be applied, or the wire would not pass easily; that is, if the same degree of reduction in the size of the wire was attempted, it would break or strain the wire, if the hole was cylindrical, although it would pass through a regular taper hole. The hole sometimes wears irregularly, and loses its circular figure. In this case, the plate is hammered around the small end of the hole, and the hole is thereby reduced. The punch is then driven in, to enlarge it again to the required size: sometimes the punch is introduced at the small end, and then at the large end, as it may be required to form the hole. In all cases, the punch must be driven very gently; and after every stroke of the hammer it must be loosened in the hole, and turned round before another blow is struck, and without this precaution it would fix fast in the hole.

The French draw-plates are the most esteemed; and, in time of war, a good French draw-plate has been sold for its weight in silver. M. Du Hamel, in *Les Arts et Metiers*, vol. xv. gives the following account of the process of making the draw-plates for the large iron-wire.

A band of iron is forged of two inches broad and one inch thick. This is prepared at the great forge. About a foot in length is cut off, and heated to redness in a fire of charcoal. It is then beaten on one side with a hammer, so as to work all the surface into furrows or grooves, in order that it may retain the substance called the *potin*, which is to be welded upon one side of the iron, to form the hard matter on which the holes are to be pierced. This *potin* is nothing but fragments of old cast-iron pots; but those pots which have been worn out by the continued action of fire are not good: the fragments of a new pot which has not been on the fire are better.

The workman breaks these pieces of pots on his anvil, and mixes the pieces with charcoal of white wood. He puts this in the forge, and heats it till it is melted into a sort of paste; and to purify it he repeats the fusion ten or twelve times, and each time he takes it with the tongs to dip it in water. M. Du Hamel says, this is to render the matter more easy to break into pieces.

By these repeated fusions with charcoal, the cast iron is changed, and its qualities approach those of steel, but far from becoming brittle; it will yield to the blows of the hammer and to the punch, which is used to enlarge the holes. The bar of iron which is to make the draw-plate is covered with a layer of pieces of the *potin*, or cast iron, thus prepared. It is applied on the side which is furrowed, and should occupy about half an inch in thickness. The whole is then wrapped up in a coarse cloth, which has been dipped in clay and water mixed up as thick as cream, and is put into the forge. The *potin* is more fusible than the forged iron, so that it will melt. The plate is withdrawn from the fire occasionally, and hammered very gently upon the *potin*, to weld and in some measure amalgamate it with the iron, which cannot be done at once; but it must be repeatedly heated, and worked until the *potin* fixes to the iron. The workman then throws dry powdered clay upon it, in order, they say, to soften the *potin*.

The union being complete, the plate is again heated, and forged by two workmen, who draw out the plate of one

foot to a length of two feet, and give it the form it is to have. It is well known that cast iron cannot be worked at the forge without breaking under the hammer; but in the present instance, it is alloyed with the iron-bar, and is drawn out with it. It has also acquired new properties by the repeated fusions with charcoal.

The holes are next pierced whilst the plate is hot. This is done with a well-pointed punch of German steel, applied on that side of the plate which is the iron-bar. It requires four heats in the fire to pierce the holes, and every turn a finer punch is employed, so as to make a taper hole. The makers of draw-plates do not pierce the holes quite through, but leave it to the wire-drawers to do it themselves when the plate is cold, with sharp punches, and then they open the hole to the size they desire; and although this potin is of a very hard substance, the size of the hole may be reduced by gentle blows with a hard hammer, on the flat surface of the plate, round the hole.

A great many holes are made in the same plate; and it is important that they should diminish in size by very imperceptible gradations; so that the workman can always choose a hole suitable for the wire he is to draw, without being obliged to reduce it too much at once.

To ascertain the size of the wire, gauges are used. They are commonly made of a piece of wire bent in zigzag, as shewn in *fig. 11*; and the space between every bend is of a different width; but a better sort is made of a steel-plate, with notches on the edge. (See *fig. 12*. for the standards.) These should be hardened, that they may not be subject to wear.

Fig. 13. is another kind of gauge, which is very accurate. It consists of two straight rules of steel, put together at an angle. The diameter of the wire is indicated by the depth to which it will enter into the angle; the edges of the rulers are divided into equal parts for that purpose, and numbered, to correspond with the different sizes of wire.

The wire manufactory of Messrs. Mouchel, situated at l'Aigle, in the department de l'Orne, is one of the most considerable in France. It furnishes annually, in cards for wool-combing only, an hundred thousand quintals of iron-wire, each 100lbs. A part of this is consumed in France, and the rest is exported to Portugal, Spain, Italy, and even to the shores of the Levant.

They employ the iron manufactured in the departments of l'Orne and La Haute Saone, as being of the best quality. The first produces the best wire for making screws, nails, and pins, as much on account of its hardness as its fine polish, which resembles steel-wire. In this respect, it is superior to the iron of Haute Saone, but from its ductility the latter can now be made extremely fine, and it appears to be most free from heterogeneous particles.

The smelted iron, prepared and hammered, being in a state nearly fit for their purpose, is transported, at a small expence, to l'Aigle, by the rivers and canals. They have a forge to reduce the steel and iron of Normandy, which arrives in large pieces, into small and regular bars.

When the iron is formed into an irregular bar of about a centimetre, near four-tenths of an inch in diameter, they begin to draw it into wire. Although it be already much extended by hammering, it is in the first place passed four times through the drawing-plate; then its molecules become disposed lengthways, and exhibit fibres at their utmost extension. The fibres must be removed by means of heat, which disperses and divides them; and after that the wire may again be reduced three numbers. The fibres which are re-produced by this operation are again removed by heat. The whole process is five times repeated; conse-

quently the wire is passed through fifteen numbers; after which, a single exposure to the fire is sufficient to fit it for passing six others, whereby it is reduced to the thickness of a knitting-needle.

The steel-wire, being much harder, requires to be passed through forty-four numbers, and to be annealed every other time.

The machine which draws the steel-wire must go slower than that which draws the iron; for the first being very hard, and offering more resistance to the drawing-plate, should be pulled out with more care, since the quickness ought to be proportioned to the resistance, and reciprocally; and if they depart from this principle, the results will vary. Thus, for example, the iron of the department de l'Orne, which is more compact than that produced at Haute Saone, if drawn by the same machines, augments in hardness, and is weakened when it is brought to too great a degree of fineness. But this iron, which is very hard, and capable of receiving a very high polish, is to be preferred for certain uses.

In order to anneal the wire, they formerly employed a large and elevated furnace, with bars of cast iron to support the wire in the middle of the flames. It contains seven thousand pounds weight, so contrived as to contain equal portions of each number. They are so arranged that the thickest wires receive the strongest heat; therefore, the whole is equally heated in the same space of time. The operation lasts three hours with a fire well kept up, and it might be imagined that this apparatus was completely adapted to the purpose; but there are imperfections in this method, because it leaves the wire exposed to the contact of the atmospheric air, the oxygen of which seizes it with extreme avidity; whence a considerable quantity of oxyd is occasioned, and also an operation to free it from the scales, which consists of beating the bundles of wire with a wooden hammer wetted with water.

Notwithstanding this precaution, there often remains a portion of oxyd adhering to the surface of the metal, which streaks the draw-plate, or fixes on the wire, and gives it a tarnished appearance, and causes it to break when it is brought to a great degree of fineness. This furnace is only used for the steel-wire, or the iron from l'Orne, which is less liable to change, and besides being harder is not so easily attacked by the oxygen.

In order to diminish the waste that the fire occasions, they have contrived another process, which consists in dipping the bundles of wire into a basin of wet clay before they put them into the furnace; and they are left in the furnace to dry before the fire is lighted, without which precaution the clay would peel off from the iron.

For making wire for cards, M. Mouchel invented another furnace. It is round, and about one metre six decimetres in diameter, and one metre eight decimetres in height, without including its parabolic arch and the chimney above it. The interior is divided by horizontal grates into three stories; the lowest receives the cinders, the second is the fire-place, and into the third or upper place they slide a rouleau of wire, weighing one hundred and fifty kilogrammes, which is inclosed in a space comprised between two cast-iron cylinders, being luted to prevent the admission of air between them. The flames circulate about the outside of the first, and within the interior of the second, which defends the wire from atmospheric air. The diameter of the largest cylinder is about one metre four decimetres, that of the second one metre. Thus the space comprised between them is two decimetres, on an elevation of five decimetres. There must be several pairs of cylinders provided; because whilst one pair

pair is in the furnace another must be prepared to receive a fresh rouleau of wire. They are changed every hour by means of a long iron lever, with which a single man can easily push them in and draw them out again, as the cylinder slides on cast-iron rails.

They are very careful not to open the cylinders immediately on their being drawn out of the fire; for the rouleaus of wire contained in them, being still red, would oxydate quite as much as if they had been heated in the midst of the flames without the least precaution.

The opening contrived for the passage is on the side, and has a door of cast iron, with a groove which winds round the furnace. The fire-place has one something similar to it. That of the ash-hole is vertical, in order that it may be raised to increase the fire at will.

When the iron-wire is reduced to the thickness of a knitting-needle, it is made up in bundles of 125 kilogrammes (275 pounds) each, into a large iron vessel, in order to anneal it sufficiently to be reduced for the last time. This vessel is placed upside-down in the middle of a round furnace, which is so constructed as to sustain burning coals all round it, and of which it consumes 35 kilogrammes (77 pounds) before the operation is completed. The cover must be carefully luted, as the slightest admission of air is sufficient to burn the external surfaces of the wire to an oxyd, which cannot afterwards be reduced.

When one of these vessels is sufficiently heated, it is filled with water, containing three kilogrammes (six pounds and a half) of tartar, and suspended over the flames of the furnace to make it boil. This solution, without attacking the metal, frees it from the grease and the little oxyd that adheres to it. This is the last operation in which the wire is exposed to the fire; and it is then in the proper state for being reduced to the utmost degree of fineness it is capable of sustaining, and will preserve enough of the effect of the annealing to require it no more. But when the natural hardness of the iron varies, this last exposure to the fire should take place in proportion to its thickness. As steel loses its capacity of extension much sooner than iron, it is annealed until it is no thicker than a sewing-needle. The space which is left in the vessel is filled up with charcoal-dust, which prevents it from losing the quality of steel, and preserves the heat long enough to give it the proper degree of pliancy.

As Messrs. Mouchel always use iron and steel of the same manufactory, they have been able to reduce their operations to a general system; and to attain this end, have determined a graduated scale, by which the wire will not be more stretched in the drawing-plate in one number or size than another. The following is the method they contrived, in order to form this scale for the iron-wire. They take a certain quantity of various thicknesses, which has been drawn as fine as the iron would bear. The smallest size is 100,000 metres (109,333 yards) in length to the kilogramme, 2.2 pounds avoirdupois. They note the weight that each might be capable of supporting without breaking. This being expressed by figures, it is easy, by a few interpolations, to express them in a progressive form. This kind of scale has been partly formed by comparing the weight of the different sizes with equal lengths, from which gauges or calibres may be made for the use of the workmen. These gauges are certain guides, which they cannot mistake except through great carelessness. If they had not these guides they would often pass the wire through holes in the drawing-plate that are too large for it, whence it does not acquire the strength it should have in proportion to its thickness, and loses its hardness. They might also pass it through holes

that were too small, which would weaken it, and render it very brittle. In the latter case, it frequently happens that the steel of the drawing-plate, being unable to sustain the force to which it is exposed, will give way, as if the plate were too soft; and the wire will be brittle at the beginning, and soft and too thick at the other extremity.

The greatest part of the fine wire of Messrs. Mouchel's manufactory is drawn by workmen who are dispersed about the country; but they have also a machine which moves twenty-four bobbins in a horizontal direction, which only requires the workman to look after it. It is upon the bobbins that the wire is reduced to the different degrees of thinness desired; therefore, this is the last operation in the art of making iron and steel wire; although it has all requisite qualities given to it in the work-shop of the wire-drawer.

Wire is still incapable of being made into needles and carding-hooks, until it has undergone another operation for dressing or straightening the wire, by which it is made to lose the bend or curve that it acquires on the bobbins.

This work consists in drawing the wire between nails fixed in a piece of wood, and which act to bend the wire, first in one direction, and then in the opposite, in a waving line, of which the waves are at first larger, but decrease gradually, and the last bend of which tends to force the wire into a straight line. The dresser is obliged constantly to adjust the nails, by inclining or raising them with strokes of the hammer. Also for each number of wires the pins must be at different and calculated distances. This requires a workman of intelligence, diligence, and address.

An ingenious instrument is now appropriated to this operation, and removes all difficulty. Six little puppets of very hard steel are substituted for the nails of the ordinary instrument, and are fixed on parallel bars of metal, so jointed together that the movement of them all will be parallel, and the puppets are widened or brought nearer together by screws. The wire is drawn between these puppets in a zigzag or waving line, and the repeated flexures break the sinuosities of the wire. There is a conductor of the wire to the puppets, and another conductor which serves to prevent the wire from being shaken. There are slight grooves at the extremity of the puppets, to give a passage to the wire. A scale sustained by a screw indicates the distance at which the puppets should be placed from each other, to straighten each size of wire. This forms an invariable rule, and the dresser (who may be a child) saves a third of the time which is employed in regulating the nails of the instrument formerly used. There is nothing more to be done but to draw out the wire by means of a wheel, on which he reels it, and then forms it into bundles to be delivered to the consumers.

The steel-wire of France is proper for many purposes. It is brought from Messrs. Mouchel, for making knitting-needles in the English fashion, shoemakers' needles, and other similar articles. It may also be used for needles of all sizes, and even for cards for wool-combing; but as this steel is much more expensive than the iron-wire, it is very seldom used for the latter purpose.

The method of preparing the draw-plates is described by Messrs. Mouchel, and is different from that before described.

For making wire for cards, two sorts of drawing-plates are used, large and small ones. The first, for the sort of wire that we have been describing, is drawn with the pincers, as *fig. 7*, and with the bobbin or roller, which is a cylinder adapted to the axis turned by the water-mill, and is used in preference, to avoid the marks made on the wire by the pincers. The small drawing-plates are used for such wire

as may be drawn by hand. The steel which they employ for these drawing-plates should never vary in quality, except that the smaller plates are made of the finest steel. Several pieces of iron are disposed in the furnace in the form of a box without a lid, their weight being according to the use for which they are intended to be employed.

The workman fills each of these boxes with cast steel, and having covered it over with a luting of clay, it is exposed to a fierce fire until the steel be melted. His art consists in seizing the proper moment to withdraw the plate from the fire: he raises the luting, and blows on it through a tube, in order to drive off all heterogeneous parts, and then amalgamates it with the iron by light blows. After it is cool, he replaces it at the fire, where the fusion again takes place, but to a less degree than before; he afterwards works the steel with light blows of the hammer, to purify and solder it with the iron. This operation is repeated from seven to ten times, according to its quality, which renders it more or less difficult to manage. During this process, a crust forms on the steel, which is detached from it the fifth time of its exposure to the fire, because this crust is composed of an oxydated steel of an inferior quality. It sometimes happens that two and even three of these crusts are formed of about two millimetres, or one-sixteenth of an inch in thickness, which must also be removed.

After all these different fusions, the plate is beaten by a hammer wetted with water, and the proper length, breadth, and thickness, are given to it. When thus prepared, the plates are heated again, in order to be pierced with holes by punches of a conical form; the operation is repeated five or six times, and the punches used each time are progressively smaller. It is of importance that the plate never be heated beyond a cherry-red, because if it receives a higher degree of heat, the steel undergoes an unfavourable change. The plates, when finished, present a very hard material, which nevertheless will yield to the strokes of the punches and the hammer, which they require when the holes become too much enlarged by the frequent passing of the wire through them.

When the plates have been repaired several times, they acquire a degree of hardness, which renders it necessary to anneal them, especially when they pass from one size to another; sometimes they do not acquire the proper quality until they have been annealed several times. Notwithstanding all the precautions which are taken in preparing the plates, the steel still varies a little in hardness, and according to this variation they should be employed for drawing either steel or iron wire; and if the workman who proves them finds that they are too soft for either the steel or iron, they are put aside, to be used by the brass-wire drawers.

A plate that is best adapted for drawing steel-wire is often unfit for the iron; for the long pieces of this latter metal will become smaller at the extremity than at the beginning, because the wire as it is drawn through the plate is insensibly heated, and the adhering parts are swelled, consequently pressed and reduced in size towards the latter end. The plates that are fit for brass are often too soft for iron, and the effect resulting is the reverse of that produced by a plate that is too hard.

The smallest plates which Messrs. Mouchel use are at the least two centimetres, or eight-tenths of an inch in thickness, so that the holes can be made sufficiently deep; for when they are of a less thickness, they will seize the wire too suddenly and injure it. This inconvenience is much felt in manufactories where they continue to use the plates for too long a time, as they become exceedingly thin after frequent repairs. One of Messrs. Mouchel's large plates

reduces 1400 kilogrammes (3080 pounds avoirdupois) from the largest size of wire to No. 6, which is of the thickness of a knitting-needle; 400 kilogrammes (880 pounds) of this number are afterwards reduced in one single small plate to No. 24, which is carding wire; and to finish them, they are passed through twelve times successively.

For the tenacity of iron wire, see IRON.

The first wire-mill in England was set up by a Dutchman at Sheen, near Richmond, in 1663.

Wires are frequently drawn so fine, as to be wrought along with other threads of silk, wool, or hemp: and thus they become a considerable article in the manufactures. See DUCTILITY.

WIRE, Gold. See GOLD-WIRE.

Muschenbroeck records, that an artist of Augsbourg drew a wire of gold so slender, that 500 feet of it weighed only one grain; and Dr. Wollaston, secretary of the Royal Society, has shewn, that a wire of gold may be drawn much finer than this, and that wires of platina may be drawn much more slender, with the utmost facility. Those who draw silver-wire in large quantities for lace and embroidery, sometimes begin with a rod that is about three inches in diameter, and

ultimately obtain wires that are so small as $\frac{1}{100}$ of an inch in

thickness. If in any stage of this process a rod of silver-wire be taken, and a hole be drilled through it longitudinally, having its diameter one-tenth part of that of the rod, and if a wire of pure gold be inserted, so as to fill the hole, it is evident that by continuing to draw the rod, the gold within it will be reduced in diameter exactly in the same proportion as the silver; so that if both be thus drawn out

together till the diameter of the silver is $\frac{1}{500}$ of an inch, then

that of the gold will be only $\frac{1}{5000}$; and of such wire, 550

feet would be requisite to weigh one grain. In order to remove the coating of silver that surrounds it, the wire must be steeped for a few minutes in warm nitrous acid, which dissolves the silver without any injury to the gold. Dr. W., in his endeavours to make slender gold-wires by the method above-described, found it difficult to drill the central hole in a metal so fine as silver, and therefore tried whether platina might not be substituted for the gold, as in that case its infusibility would allow its being coated with silver, without the necessity of drilling. Having formed a cylindrical mould one-third of an inch in diameter, he fixed in the centre

of it a platina wire previously drawn to the $\frac{1}{100}$ of an inch,

and then filled the mould with silver. When this rod was

drawn to $\frac{1}{30}$, his platina was reduced to $\frac{1}{1000}$, and by suc-

cessive reduction he obtained wires of $\frac{1}{4000}$ and $\frac{1}{5000}$, and

excellent for applying to the eye-pieces of astronomical instruments, and perhaps as fine as can be useful for such purposes. The extremity of a platina wire having been fused into a globule near $\frac{1}{4}$ of an inch in diameter, was next hammered out into a square rod, and then drawn again into a

wire $\frac{1}{253}$ of an inch in diameter. The fusion was effected

by the following simple and easy method suggested by Dr. Marcet:

Marcel:—A piece of wire, about six inches long, having been bent to an angle in the middle, one half of its length was held in the flame of a spirit-lamp impelled by a current of oxygen, and its extremity was thus fused in about half a minute. An inch of the wire above-mentioned duly coated with silver was drawn, till its length was extended to 182 inches; consequently the proportional diminution of the diameter of the platina will be expressed by the square root of 182, so that its measure had become

$$\frac{1}{253 \times 13.5} = \frac{1}{3425}$$

The specific gravity of the coated wire was assumed to be 10.5, and since the weight of 100 inches was 114 grains, its diameter was inferred to be

$$\frac{1}{42.8}$$

of an inch, and just eighty times of the platina thus contained in it. With portions of the platina wire thus obtained, and successively reduced in diameter, its tenacity was ascertained; and the results of several trials shewed in general, that the process of wire-drawing, which is known to improve the strength of metals within moderate limits, continued also to add something to the tenacity of platina,

even as far as $\frac{1}{18,000}$ of an inch, which supported $1\frac{1}{2}$ grain

before it broke; but the wire in which the experiments were made began then to be impaired by repetition of the operation; so that although he afterwards obtained portions

of it as small as $\frac{1}{30,000}$ of an inch in diameter, it was in

many places interrupted, and he could not rely on any trials of its tenacity. For other particulars with regard to these fine wires, we refer to the Phil. Trans. vol. ciii. pt. 1.

WIRE, Silver, is the same with gold wire, except that the latter is gilt, or covered with gold, and the other is not. There are also counterfeit gold and silver wires: the first made of a cylinder of copper, silvered over, then covered with gold; and the second of a like cylinder of copper silvered over, and drawn through the iron, after the same manner as gold and silver wire.

By 43 Geo. III. c. 68. several duties are imposed on wire imported, as set forth in tables annexed to the act; and by c. 69. sched. A. duties are laid upon wire made in Great Britain; and by 49 Geo. III. c. 98. new duties are imposed. Every wire-drawer who shall draw any gilt or silver wire, commonly called 'big wire,' shall take out a licence, for which he shall pay 2*l.*, to be renewed annually on pain of 20*l.* 24 Geo. III. c. 41. One licence suffices for a partnership. Notice is to be given of working on pain of 20*l.*, and the place of working is to be approved by the commissioners under the same penalty. Wire, and bars for making it, and utensils, found in any private workhouse, of which no notice hath been given, shall be forfeited. Officers shall be permitted to enter and survey, and the penalty of obstructing him is 20*l.* 10 Ann. c. 26. Preventing him from taking a just account incurs a forfeiture of 100*l.* 26 Geo. III. c. 77. Just scales and weights shall be kept on pain of 10*l.* Persons using false scales and weights forfeit 100*l.* 10 Geo. III. c. 44. And the same shall be forfeited and seized. 28-Geo. III. c. 37. Ingots or bars of silver, designed for gilt wire, shall be weighed in the presence of the excise officer, before they be covered with gold, and again weighed and marked after the gold is laid on, under penalty of 20*l.* 15 Geo. II. c. 20.

By 10 Ann. c. 26. an allowance of one-fifth is made

for waste in reducing the big wire to small wire. Removing wire before it is surveyed incurs a penalty of 40*l.*; and unsurveyed wire is to be kept separate, on pain of 10*l.*; and the punishment of concealing wire, &c. is a forfeiture of 20*l.* The wire made shall be entered every month, on oath, on pain of 100*l.* The duty must be cleared off in six weeks after entry, on pain of double duty.

By 15 Geo. II. c. 20. and 22 Geo. II. c. 36. no foreign embroidery, or gold or silver brocade, thread, lace, fringe, or work made thereof, or of copper, brass, or other inferior metal, or gold or silver wire, or plate, shall be imported. And by 10 Ann. c. 26. if any person shall export any gold or silver thread, or lace or fringe made of plate wire spun upon silk, he shall have a drawback after the rate of 5*s.* a pound avoirdupois, of such wire thread, lace, or fringe, and of 6*s.* 8*d.* a pound of such gold thread, lace, or fringe.

For regulations concerning the true making of gilt and silver wire, see the statute 15 Geo. II. c. 20. and for prohibiting the felling or working up of foreign gold or silver lace or thread, see 22 Geo. II. c. 36.

WIRE, Brass, is drawn after the same manner as the former. Of this there are divers sizes, suited to the divers kinds of works. The finest is used for the strings of musical instruments, as spinets, harpsichords, manichords, &c.

The pin-makers likewise use vast quantities of wire of several sizes, to make their pins of. See PIN.

WIRE, Iron. See WIRE *supra*.

WIRE-Gauze Safety-Lamp, and **Safety-Lamp**, in the Arts, are lamps constructed to prevent the explosion of inflammable air in mines, by intercepting the communication of the flame on the inside of the lamp with the surrounding atmosphere. The discovery of safety-lamps for this purpose belongs exclusively to our own country, and will form a new era in mining operations. We shall, therefore, state the history of their invention with as much accuracy as possible, amidst the contending claims of the different inventors for priority. The explosions of inflammable air in coal-mines arise from the ignition of carburetted hydrogen evolved from the strata, and mixed with the atmospheric air that circulates through the mine. These explosions very frequently occasion the most fatal effects, destroying the lives of all the persons employed as well as of the horses, and producing great mischief to the subterranean works. Some mines are much more liable to accidents from this cause than others. In some the carburetted hydrogen accumulates slowly from the want of due circulation; in other mines, it is generated very rapidly, issuing from fissures called blowers, which occur either in the roof, the floor, or the sides of the mine.

In the coal-fields of the Tyne and the Wear, it has been estimated that six hundred men and boys were destroyed in two years by explosions in the mines; but these accidents, unless they took place on a large scale, were as much as possible kept from public notice, partly from the fear of alarming the workmen, and partly from the apprehension of blame to the viewers and managers of the works. Of these melancholy catastrophes, few registers are kept in any part of Great Britain; but in the year 1810 an explosion took place in a mine in the parish of Felling near Newcastle, which, from the magnitude of the evil it occasioned, excited a general sensation of horror throughout the country. In this mine, the property of wealthy and liberal owners, no expence had been spared in the introduction of machinery and the most approved methods of ventilation. (See VENTILATION of Mines.) Notwithstanding this, on the 25th of

May 1812, the inflammable air exploded in two discharges from one of the pits, which was shortly followed by a third from another pit.

The depth of these explosions under the surface out-tuned the sound of the reports; but for half a mile round the vibrations of the earth announced the occurrence of the accident before the noise escaped, and an alarm was created four or five miles round by low and hollow rumblings in the air. Immense volumes of dense vapour and coal-dust, with pieces of wood and coal, were driven high into the atmosphere; and the mangled bodies of several men and boys were absolutely thrown out of the shaft. The country in the immediate vicinity was enveloped in darkness, and every kind of machinery near the mouths of the pits was blown to pieces, or set fire to. Out of a hundred and twenty men and boys employed in the mine only thirty-two were saved, three of whom afterwards died. The coal being set fire to, and the subterranean works blown down or destroyed, the owners were compelled to close the mouths of the pits in order to extinguish the fire; and it was not till the seventh or eighth of the following month that it could be re-opened to extract the bodies, which were, many of them, too much mangled, and in too putrescent a state, to be identified by the relatives. A series of similar disasters, in each of which from twenty to thirty-five human beings were destroyed, occurred soon afterwards in the same districts, and even in the Felling mine another explosion took place in December 1813, by which twenty-three men and boys and twelve horses were killed. The only method that had been adopted to prevent explosions, besides the usual modes of ventilation for clearing the mine, was the substitution of steel-mills for candles.

The steel-mill is an instrument for producing light by the collision of flint and steel: it consists of a brass wheel about five inches in diameter, with fifty-two teeth, which works a pinion with eleven teeth. On the axis of the pinion is fitted a thin jagged steel wheel, from five to six inches in diameter; against the circumference of this wheel the sharp edge of a flint is fixed, and the toothed wheel has a handle, which is turned by a boy; the whole machine being fixed in an iron frame suspended by a leather belt. The steel wheel revolves with great velocity, and elicits a stream of scintillations, which give a considerable light. Where the mines were suspected to contain inflammable air, these machines were used; but besides affording only an unsteady light, and being difficult to manage, many instances had occurred of the air igniting from the scintillations of steel-mills. For the purpose of exploring the unworked and more dangerous parts of the mine, the steel-mill was both an inconvenient and incomplete instrument; but until the year 1809 no method of lighting had been attempted which might supersede its use.

About that time Dr. Reid Clanny, a scientific and ingenious physician at Sunderland, commenced a series of experiments, with a view to insulate the gas which might explode in a lamp, and cut off its communication with the surrounding air in the mine. With this intent, he constructed a lamp in which the combustion of the oil or tallow is supported by the ordinary air of the coal-mine supplied by a pair of bellows, and passing through a stratum or reservoir of water below the light; at the same time, a portion of the air already in the lamp is driven through another reservoir in the upper part above the light, and thus the air supplied may explode within the body of the lamp without communicating the flame to the external air, however highly it may be charged with carburetted hydrogen gas. The moment the air enters the lamp it comes in contact with the flame, and consequently only a small portion of it can be exploded, instead

of the whole contents of the lamp; by this means several obvious advantages are secured. The air passing in a brisk current close by the flame carries the snuff with it, so that the light is always clear and steady. The other parts of the lamp were air-tight, and the whole made very strong, with a glass nearly half an inch thick to prevent it from being broken by any common accident. It is capable of being managed by a boy at a much less expence than the steel-mill. This lamp, which, for strength and for security from explosions and accidents, exceeds any other that has since been invented, excited little attention among the coal-workers where it was first made known. Had not the prejudices against improvements prevented its general introduction, more than one thousand lives might have been preserved, which were destroyed in the mining districts of the Tyne and Wear in a few years after its discovery. In its first form, the lamp, though secure, was not made sufficiently light to be portable without being placed on a barrow; but Dr. Clanny afterwards improved it in this respect, by substituting a small pair of bellows to be worked under the right arm; the lamp, being suspended by a leather belt from the left side of the boy who carried it, might in this way be moved into the narrowest or most dangerous parts of the mine. A description of Dr. Clanny's safety-lamp, with a plate, was first given in the Philosophical Transactions of the Royal Society for 1813, part ii. p. 200. In this lamp, however strong may be the currents of air in the mine, the flame cannot be affected by them, and the most dangerous *blower* may be approached in perfect safety. When an explosion takes place in the lamp it extends no farther, and the flame is instantly extinguished; and wherever there is sufficient atmospheric air to support life, this lamp will afford a safe and abundant light. The construction of the lamp was rendered more simple by passing the air through the oil, by which the necessity of the lower reservoir of water was avoided.

In *Plate I. fig. 2. Geology*, is given an outline of the lamp on its original principle, which, though less portable, is, we consider, the safest that has yet been employed. A is the body of the lamp, constructed of copper or block-tin; B, the upper part of the lamp, ending in a conical bent tube, by which the air is discharged after supporting combustion through the water-cistern C and D, the part D being filled with water to keep the lamp cool, if necessary; E, the window of the lamp, made of very thick glass; F, the candle, supported on a tin stand; G, a cistern containing water, through which the air is forced by the bellows; H, a tube from the bellows, which conveys air to the lamp. A flexible leather tube may be fixed to the valve of the bellows, to send atmospheric air from a distance, if necessary. If the lamp be in order, it is scarcely possible to conceive any insulation of the flame more perfect than it presents; and to Dr. Clanny must be allowed the undoubted claim of priority in having first directed the attention of miners to a method of avoiding danger before unknown, and of shewing practically how it might be effected. In the improvement which Dr. Clanny made in this lamp afterwards, to render it more portable, (see *fig. 3.* in the same plate,) *a* is the tube fixed to the lamp, and which conveys the air; *b*, the oil-cistern; *c*, the air aperture, under the burner of the oil; *d*, the flexible tube connected with the bellows; *e, f*, the glass. In both these lamps, the air being supplied by bellows, required the constant attention of a boy; this, however, was the case with the steel-mills, which were in general use before. A lamp that would supply itself with atmospheric air was still a desideratum; when Dr. Clanny discovered, in November 1815, as he was making experiments with the original safety-lamp in an atmosphere of fire-damp in

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in the Horrington mine, near Sunderland; that if the insulation of the lamp were made with hot water, the fire-damp burned silently at the wick, and did not explode within the lamp, as formerly. This he ascertained to be owing to the steam; and he farther discovered, that one part in volume of steam to two of the most explosive mixtures destroyed their inflammability. A similar effect of steam had been before noticed by Von Grothuss, in the 82d volume of the *Annales de Chimie*, but had not been applied to any useful purpose. In December of the same year, Dr. Clanny constructed a steam safety-lamp, which he exhibited to the Society, for preventing accidents in coal-mines, and received their unanimous thanks; and in 1817 he received a gold medal from the Society of Arts for the discovery.

In the steam safety-lamp there is a reservoir of water at the top of the lamp, which is a closed tin box, or cistern. The water is kept boiling by the flame of the lamp, and the steam mixing with the carburetted hydrogen prevents all risk from explosion. The air is supplied through a tube to the upper part of the cistern above the water, and descends, mixed with the steam, down two other tubes, into the body of the lamp. By this means, the fire-damp burns silently and steadily at the wick of the lamp alone for any length of time. Should the carburetted hydrogen exceed the proportion of atmospheric air for supporting combustion, the light is extinguished, but this can rarely happen. It has also the valuable property of keeping cool throughout every part, and under all circumstances; this is effected by the evolution and motion of the steam. This lamp, says Dr. Clanny, is now well known to burn most brilliantly in an atmosphere of fire-damp, even after the original safety-lamp has had the fire-damp exploded within it. The steam-lamp has now been extensively used in several of the northern collieries. Its great recommendation over other inventions is the superior light which it affords. These lamps are made of the strongest tinned iron, with a flat glass in front, three-eighths of an inch in thickness. They are exceedingly strong and durable, and cost about twelve shillings, but might be manufactured on a large scale for half the price.

Fig. 4. represents the short tube by which the air enters into the tube *b*, and this tube supports the water-cistern *c* at the top, being fitted into the tube *a* at the bottom, so as to be taken out and replaced when the water is to be poured in or removed from the cistern *c*. The air which ascends the tube *b* mixes with the steam of the water-cistern, and passes down the two tubes *d*, *d*, to support the combustion of the flame, and afterwards ascends by the side of the cistern through the chimney of the lamp. These tubes are closed at the bottom, and perforated on the sides, to retard the progress of the air, and mix it with the steam before it reaches the flame *e*. The bottom is air-tight; *f* the glass, and *g* the oil-lamp. These lamps are twelve inches in length, exclusively of the chimney. They should be cleared of water, and well dried, after they have been in use, that they may be more durable. When the lamp is first lighted it is necessary to establish a current, which is best done by turning the lamp, so that the tube *a* may be exposed to the current of air; this will be effected in five minutes, and the lamp will afterwards continue to burn regularly and steadily.

Dr. Clanny farther applied the same principle to the construction of a larger lamp, in which were three wicks to burn the inflammable air as it was made to issue through the oil; this is intended to consume the hydro-carburetted gas as it rushes from a blower.

In the history of useful inventions, perhaps no instance of supineness can be adduced, among those interested in any dis-

covery, which equals the inattention shewn for several years by the coal-workers in the north to the valuable labours of Dr. Clanny. We had an opportunity of examining his lamp in 1813, and were satisfied with the complete security which it affords. At that time, however, so far from receiving the patronage he highly merited, he was regarded by many with a strange jealousy, as an officious intruder into the mysteries of mining; mysteries which he had no right to investigate. To Dr. Clanny, however, the first discovery of a safety-lamp is undoubtedly due; and we have no hesitation in asserting our belief that his original safety-lamp is the most secure of any that have since been invented, where dangerous parts of the mine are to be explored, on account of its more complete insulation, and its greater strength. His lamp had also the merit of first suggesting the possibility of insulating the flame in the different lamps which have since been constructed.

The attention of the public was at length directed to the dangerous situation of the men working in the mines by a few gentlemen, who formed a society, in 1813, at Sunderland, entitled *A Society to prevent Accidents in Coal-Mines*. Dr. Gray, rector of Bishop-Wearmouth, an active member of this society, invited sir H. Davy, in 1815, who was then on a visit in the north of England, to examine the collieries with a view to assist the efforts of the society to prevent the accidents to which they were subject. From the information communicated to him by persons employed in the mines, he was induced to commence a series of experiments on carburetted hydrogen gas, which led to several unexpected results, not less interesting to science than useful in their application to the arts. Before proceeding to describe these, we must notice the labours of Mr. Stephenson, an engineer in the Killingworth main colliery, who previously to this time had, as he asserts in a pamphlet on the subject, entitled "*A Description of the Safety-Lamp invented by George Stephenson*," made the discovery that inflammable air will not explode through small apertures. In the same pamphlet he states, that a lamp constructed by him on this principle was tried in the above colliery on the 21st of October 1815, the lamp being carried in safety into a part of the mine where a strong blower of inflammable air was issuing. The experiment, he adds, was immediately repeated in the presence of two persons employed in the works.

These lamps, judging from Mr. Stephenson's own description, yielded but a feeble light. They were afterwards improved; but these improvements bear so close a resemblance to parts of sir H. Davy's lamp, hereafter to be described, that we conceive Mr. Stephenson must labour under no small difficulty in establishing his claim for their original invention. The question, at present agitated with much warmth, can only be decided by a reference to well-established dates and authentic evidence; an investigation not suited to the nature of the present work.

We have little doubt that the insulation obtained in Dr. Clanny's lamp by water first suggested to Mr. Stephenson the possibility that small apertures might intercept the extension of the flame as effectually as water. On this suggestion his first lamp appears constructed, the tube which admitted the air being covered with a slide, to diminish the aperture at pleasure; but the quantity of air which could be safely admitted through one aperture being inadequate to the support of the flame, it was obvious that the only way to ensure both light and safety was to increase the number of apertures, diminishing the size of each. In this manner, it appears that Mr. Stephenson proceeded mechanically, without a correct knowledge of the properties of the gas, or the principles on which the effects were produced. We think, however, that

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that as an approximation to a valuable discovery, Mr. Stephenson's lamp entitled him to the patronage and support which he has received. It ought also to be recollected that Dr. Clanny and Mr. Stephenson both laboured under the disadvantage of living at a distance from the residence of ingenious practical mechanics to execute their inventions in the most simple, cheap, and portable manner; an advantage only to be obtained in the neighbourhood of the metropolis, or of large mechanical manufactories.

Sir H. Davy, after ascertaining that the fire-damp, or inflammable air in coal-mines, is the light carburetted hydrogen gas, as stated by other chemists, proceeded to examine accurately its combustibility and explosive nature. When one part of fire-damp was mixed with one of common air, the mixture burned on the approach of a taper, but did not explode. Two of air and three of fire-damp produced similar results. When four of air and one of fire-damp were exposed to a lighted candle, the mixture being in the quantity of six or seven cubic inches in a narrow-necked bottle, the flame descended to the bottom, but there was no noise. One part of gas inflamed with six parts of air in a similar bottle, producing a slight whistling sound. One part of gas with three of air rather a louder sound. One part with ten, eleven, twelve, thirteen, and fourteen parts, still inflamed, but the violence of the combustion diminished. In one part of gas and fifteen parts of air, the candle burned without explosion, with a greatly-enlarged flame. The same effect was observed, but in a gradually diminishing ratio, as far as thirty parts of the gas to one of common air. The mixture which seemed to possess the greatest explosive power was seven or eight parts of air to one of gas; but the report produced by fifty cubic inches of this mixture was less than that produced by one-tenth of a mixture consisting of two parts of common air and one of pure hydrogen.

It was also very important to ascertain the degree of heat required to explode the different mixtures of fire-damp. A common electrical spark, he found, would not explode five parts of air and one of fire-damp, though it exploded six parts of air and one of the latter gas. Very strong sparks from the discharge of the Leyden jar seemed to have the same power of exploding different mixtures of the gas, as the flame of a taper. Well-burned charcoal, ignited to the strongest heat, did not explode any mixtures of the gas; and when a fire of the same charcoal, which burned without flame, was blown to whiteness by an explosive mixture without producing inflammation. An iron rod at a red or even at a white heat did not inflame explosive mixtures of the gas; but when in brilliant combustion it produced that effect.

The flame of gaseous oxyd of carbon, as well as of olefiant gas, exploded the mixtures of the fire-damp.

In respect of combustibility, says Sir H. Davy, the fire-damp differs materially from the other common inflammable gases. Olefiant gas, when rendered explosive by a mixture of common air, is fired both by charcoal and iron, heated to a dull redness. Gaseous oxyd of carbon, which explodes with two parts of air, is likewise inflammable by hot iron or charcoal. And hydrogen, which explodes when mixed with three-sevenths of air, takes fire at the lowest visible heat of iron or charcoal; and the case is the same with sulphuretted hydrogen.

The importance of these experiments is too obvious to require illustration. Having ascertained the above facts, Sir H. Davy proceeded to examine the degree of expansion of mixtures of fire-damp and air during their explosion, and likewise their power of communicating flame through aper-

tures to other explosive mixtures. It is to this latter part of Sir H. Davy's experiments and its application to safety-lamps, that the controversy respecting the priority of the discovery refers.

When six parts of air and one of fire-damp were exploded over water by a strong electrical spark, the explosion was not very strong; and at the moment of the greatest expansion, the volume of the gas did not appear to be increased more than one-half. In exploding a mixture of one part gas from the distillation of coal, and eight parts of air in a tube one-quarter of an inch in diameter, and one foot long, more than a second was required before the flame reached from one end of the tube to the other, and he could not make any mixture explode in a glass tube one-seventh of an inch in diameter; and this gas was more inflammable than fire-damp, as it consisted of carburetted hydrogen mixed with some olefiant gas.

In exploding mixtures of fire-damp and air in a jar, connected with the atmosphere by an aperture of half an inch, and connected with a bladder by a stop-cock having an aperture of about one-sixth of an inch, the flame passed into the atmosphere, but did not communicate through the stop-cock so as to inflame the mixture in the bladder; and in comparing the power of tubes of metal and those of glass, it appeared that the flame passed more readily through tubes of glass of the same diameter, and that explosions were stopped by metallic tubes of one-fifth of an inch, when they were one inch and a half long; and this phenomenon probably depends upon the heat lost during the explosion, in contact with so great a cooling surface, which brings the temperature of the first portions exploded below that required for firing the other portions.

Metal is a better conductor of heat than glass; and it has been already shewn, that the fire-damp requires a very strong heat for its inflammation.

A mixture of the gas with air, he also found, would not explode in metallic canals or troughs when their diameter was less than one-seventh of an inch, and their depth considerable in proportion to their diameter, nor could explosions be made to pass through such canals.

Azote and carbonic acid, even in small proportions, diminished the velocity of inflammation in explosive mixtures of fire-damp. Azote, when mixed in the proportion of one to six of an explosive mixture containing twelve of air and one of fire-damp, deprived it of its power of explosion; when one part of azote was mixed with seven of an explosive mixture only, a feeble blue flame passed through it.

One part of carbonic acid to seven of an explosive mixture deprived it of the power of exploding; so that its effects are more remarkable than those of azote, probably in consequence of its greater capacity for heat, and probably likewise of its higher conducting power connected with its greater density.

The consideration of these various facts, Sir H. Davy informs us, led him to adopt a form of lamp in which the flame, being supplied with only a limited quantity of air, should produce such a quantity of azote and carbonic acid as to prevent the explosion of the fire-damp; and which, by the nature of its apertures for giving admittance and exit to the air, should be rendered incapable of communicating any explosion to the external air.

If in a close lantern supplied with a small aperture below and another above, a lighted lamp having a very small wick be placed, the natural flame gradually diminishes, till it arrives at a point at which the supply of air is sufficient for the combustion of a certain small quantity of oil; if a lighted taper be introduced into the lantern through a small door

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door in the side, which is instantly closed, both lights will burn for a few seconds, and be extinguished together.

A similar phenomenon occurs: if in a close lantern supplied with a quantity of air merely sufficient to support a certain flame, a mixture of fire-damp and air is gradually admitted, the first effect of the fire-damp is to produce a large flame round that of the lamp, and this flame consuming the oxygen which ought to be supplied to the lamp, and the standard of the power of the air to support flame being lowered by the admixture of fire-damp and by its rarefaction, both the flame of the fire-damp and that of the lamp is extinguished together; and as the air contained a certain quantity of azote and carbonic acid before the admission of the fire-damp, their effect by mixing it is such as to prevent an explosion in any part of the lantern.

In an experiment which sir H. Davy made, to ascertain that the flame was extinguished in the lantern, though the mixture was still explosive which supplied the flame, the lantern was placed on a stand under a large glass receiver standing in water, which was of sufficient capacity to enable the candle to burn for some minutes. A quantity of fire-damp was thrown in from a bladder, so as to render the atmosphere explosive. As the fire-damp mixed with the air, the flame of the taper gradually enlarged till it half filled the lantern; it then gradually diminished, and was suddenly extinguished without the slightest explosion. The air in the receiver was found after the experiment to be highly explosive.

Sir H. Davy then introduced into a glass jar, containing an explosive mixture of one part fire-damp and ten parts of air, a lighted lantern, to which air was supplied by two glass tubes one-tenth of an inch in diameter, and half an inch long. The taper burned at first with a feeble light, the flame soon became enlarged, and was then extinguished. These experiments were several times repeated with a constancy of result. It is evident, he says, from hence, that it is only necessary to use air-tight lanterns supplied with air from tubes or canals of small diameter, or from apertures covered with wire-gauze, placed below the flame, through which explosions cannot be communicated, and having a chimney at the upper part on a similar system for carrying off the foul air.

This principle sir H. Davy adapted to a variety of glass lanterns, in which the air was admitted through small apertures or wire-gauze, with a top protected by the same. These lanterns, however they might have answered for experiments in the laboratory, were not, however, well fitted for practical use; for besides the fragility of common glass, which exposed the miner to explosions from the enlargement of the flame, the glass was liable to become heated and to break, however strong it might be made. This inconvenience was, however, removed by the substitution of a cylinder of fine wire-gauze, forming a close lamp or lantern, into which the air is admitted, and from which it passes through very small apertures. In the first experiments, the wire was of brass the $\frac{1}{16}$ th part of an inch in thickness, and the apertures were not more than the $\frac{1}{16}$ th part of an inch; this was found to stop explosions as well as the long tubes or canals, and to admit a free current of air. The wire-gauze lamp, in its present improved form, is the most simple and portable that has yet been introduced. *Plate V. fig. 5. Geology*, represents the lamp as at present used; *a* represents the single cylinder of wire-gauze; the foldings *aaa* must be very well doubled and fastened by wire. If the cylinder be of twilled gauze, the wire should be at least of the one-fortieth of an inch of iron or copper, and thirty in the warp, and sixteen or eighteen in the weft. If of plain wire-gauze, the

wire should not be less than one-sixtieth of an inch in thickness, and from twenty-eight to thirty both warp and weft; *b* represents the second top, which fits upon *a*; *c* represents a cylinder of brass, in which the wire-gauze is fastened by a screw, to prevent its being separated from the lamp by any blow; *c* is fitted into a female-screw, which receives the main-screw *b* of the lamp *f*, furnished with its safe-trimmer *h*, and safe-feeder for oil *i*.

Lamps on the same principle were constructed, in which the cylinder is made of copper of one-fortieth of an inch in thickness, perforated with longitudinal apertures of not more than one-sixteenth of an inch in length, and the one-thirtieth in breadth. (*See Plate I. fig. 6. Geology.*) In proportion as the copper is thicker, the apertures may be increased in size. This form of the lamp may be proper where such an instrument is only to be occasionally used, but for the general purpose of the collier, sir H. Davy states that wire-gauze is much superior from its flexibility, and the ease with which new cylinders are introduced.

To this lamp a valuable addition has been lately made by the application of a lens before the flame, to condense the rays of light, and direct them to any particular spot. It has the farther advantage of protecting that part of the wire-gauze from coal-dust, by which it is liable to be choked and obscured in a few hours.

In subsequent experiments, sir H. Davy discovered that much thicker wires and larger apertures might be used than were at first applied. This gave to the lamp greater strength, and transmitted more light.

Gauze made of brass wire $\frac{1}{16}$ th of an inch in thickness, and containing only 100 apertures in the square inch, did not communicate explosion in a mixture of one part coal-gas and twelve of common air, so long as the wire was cool; but as soon as the top became hot an explosion took place. A quick lateral motion also enabled it to communicate explosion. With 196 apertures to the square inch, the explosion was not communicated till the wire became strongly hot.

Iron wire-gauze, containing 240 apertures to the square inch, was safe in explosive mixtures of coal-gas, till it became strongly red-hot at the top.

Iron wire-gauze, of 576 apertures to the square inch, or the $\frac{1}{16}$ th part of an inch each in diameter, appears, says sir H. Davy, to be safe under all circumstances, in explosive mixtures of coal-gas. With very fine wire-gauze, mixtures of oxygen and hydrogen gases may be burned without explosion until the brass wire begins to melt.

The explanation which sir H. Davy gives of the effect of wire-gauze, and small tubes in arresting the progress of flame, is as follows:—These results are best explained by considering the nature of the flame of combustible bodies, which in all cases must be considered as the combustion of an *explosive mixture* of inflammable gas, or vapour and air; for it cannot be regarded as a mere combustion at the surface of contact of the inflammable matter: and the fact is proved by holding a taper, or a piece of burning phosphorus, within a large flame made by the combustion of alcohol; the flame of the candle, or of the phosphorus, will appear in the centre of the other flame, proving that there is oxygen even in its interior part.

The heat communicated by flame must depend upon its mass: this is shewn by the fact, that the top of a slender cylinder of wire-gauze hardly ever becomes dull-red in the experiment on an explosive mixture; whilst in a larger cylinder made of the same material, the central part of the top soon becomes bright-red. A large quantity of cold air thrown upon a small flame, lowers its heat beyond the explosive

WIRE-GAUZE SAFETY-LAMP.

explosive point; and in extinguishing a flame by blowing upon it, the effect is probably produced principally by this cause, assisted by a dilution of the explosive mixture.

If a piece of wire-gauze sieve is held over a flame of a lamp, or of coal-gas, it prevents the flame from passing it, and the phenomenon is precisely similar to that exhibited by the wire-gauze cylinders: the air passing through is found very hot, for it will convert paper into charcoal; and it is an explosive mixture, for it will inflame if a lighted taper is presented to it; but it is cooled below the explosive point, by passing through wires even red-hot, and by being mixed with a considerable quantity of air comparatively cold. The real temperature of visible flame is, perhaps, as high as any we are acquainted with. Mr. Tennant was in the habit of shewing an experiment which demonstrates the intensity of its heat. He used to fuse a small filament of platinum in the flame of a common candle; and it is proved by many facts, that a stream of air may be made to render a metallic body quite hot, yet not be itself luminous.

A considerable mass of heated metal is required to inflame even coal-gas, or the contact of the same mixture with an extensive heated surface. An iron-wire of $\frac{1}{16}$ th of an inch, and eight inches long, red-hot, when held perpendicularly in a stream of coal-gas, did not inflame it, nor did a short wire of one-sixth of an inch produce the effect held horizontally; but wire of the same size, when six inches of it were red-hot, and when it was held perpendicularly in a bottle containing an explosive mixture, so that heat was successively communicated to portions of the gas, produced its explosion.

A certain degree of mechanical force, which rapidly throws portions of cold explosive mixture upon flame, prevents explosions at the point of contact. Thus, on pressing an explosive mixture of coal-gas from a syringe, or a gum elastic bottle, it burns only at some distance from the aperture from which it is disengaged.

Taking all these circumstances into account, there appears no difficulty in explaining the combustion of explosive mixtures within, and not without the cylinders: for a current is established from below upwards, and the hottest part of the cylinder is where the results of combustion, the water, carbonic acid, or azote, which are not inflammable, pass out. The gas which enters is not sufficiently heated on the outside of the wire to be exploded; and as the gases are no where confined, there can be no mechanical force pressing currents of flame towards the same point.

Two papers by sir H. Davy, connected with this subject, were afterwards published in the Philosophical Transactions for 1817, entitled "Some Researches on Flame." In these papers, a number of new and extremely interesting experiments on the properties of flame are detailed. The practical application of the results to safety-lamps we shall briefly state, as they explain more clearly the principle on which their safety depends, and the circumstances essentially requisite to their proper construction. Sir H. Davy commences the paper by informing us, that the intensity of the light of flames depends principally upon the production and ignition of solid matter in combustion; and that the heat and light in this process are in a great measure independent phenomena: and he afterwards defines flame to be gaseous matter, heated so highly as to be luminous, and that to a degree of temperature beyond the white heat of solid bodies, as is shewn by the experiment; that air not luminous will communicate this degree of heat; for if we hold a fine platina wire one-twentieth of an inch from the exterior of the middle flame of a spirit-lamp, and conceal the flame by

an opaque body, the wire will become of a white heat in a space where there is no visible light.

When an attempt is made to pass flame through a very fine mesh of wire-gauze at the common temperature, the gauze cools each portion of the elastic matter that passes through it, so as to reduce its temperature below that degree at which it is luminous; and the diminution of temperature must be proportional to the smallness of the mesh and the mass of the metal. The power of a metallic or other tissue, to prevent explosion, will depend upon the heat required to produce the combustion, as compared with that acquired by the tissue; and the flame of the most inflammable substances, and of those that produce most heat in combustion, will pass through a metallic tissue that will intercept the flame of less inflammable substances, or those that produce little heat in combustion. Or the tissue being the same, and impermeable to all flames at common temperatures; yet when heated it will become permeable to each different kind of flame at different temperatures: those which produce most heat will most readily pass through it. A tissue of one hundred apertures to the square inch, made of wire of one-sixtieth part of an inch, will, at common temperatures, intercept the flame of a spirit-lamp, but not that of hydrogen; and when strongly heated will no longer arrest the flame of the spirit-lamp.

The ratio of combustibility of the different gases is to a certain extent proportionate to the masses of heated matter required to inflame them. Thus, an iron-wire of one-fortieth of an inch heated cherry-red will not inflame olefiant gas, but will inflame hydrogen gas: and a wire of one-eighth of an inch heated to the same degree will inflame olefiant gas; but a wire of one-five-hundredth part of an inch must be heated to whiteness to inflame hydrogen.

These circumstances will explain why a mesh of much finer wire is required to prevent the explosion from hydrogen and oxygen from passing; and why so coarse a texture of wire is sufficient to prevent the explosion of the fire-damp, the least combustible of the known inflammable gases.

The following experiments afford a satisfactory and simple explanation of the cause of the stoppage of flame by the wire-gauze lamp. Let the smallest possible flame be made by a single thread of cotton immersed in oil, and burning immediately on the surface of the oil; it will be found to be about one-thirtieth of an inch in diameter. Let a fine iron-wire one-hundred-and-eightieth part of an inch be made into a circle of one-tenth of an inch in diameter, and brought over the flame. Though at such a distance it will instantly extinguish the flame if it be cold; but if it be held above the flame, so as to be slightly heated, the flame may be passed through it without being extinguished. The effect depends entirely on the power of the metal to abstract the heat of the flame. This is shewn by bringing a glass capillary ring of the same diameter and size over the flame: this being a much worse conductor of heat will not extinguish it even when cold. If its size, however, be made greater, and its circumference smaller, it will act like the metallic wire, and require to be heated to prevent its extinguishing the flame.

Suppose a flame to be divided by the wire-gauze into smaller flames, each flame must be extinguished in passing its aperture, till that aperture has attained a temperature sufficient to produce the permanent combustion of the explosive mixture. Where rapid currents of explosive mixtures are made to act upon wire-gauze, it is of course much more rapidly heated, and therefore the same mesh which arrests the flames of explosive mixtures at rest will suffer them to pass when in rapid motion; but by increasing the cooling surface,

WIRE-GAUZE SAFETY-LAMP.

surface, by diminishing the size or increasing the depth of the aperture, all flames, however rapid their motion, may be arrested. Precisely the same law applies to explosions acting in close vessels: very minute apertures, when they are only a few in number, will permit explosions to pass which are arrested by much larger apertures, when they fill a whole surface. A small aperture was drilled at the bottom of a wire-gauze lamp, in the cylindrical ring which confines the wire-gauze; this, though less than one-eighteenth part of an inch in diameter, passed the flame, and fired the external atmosphere, in consequence of the whole force of the explosion of the thin stratum of the mixture included within the cylinder driving the flame through the aperture; though, had the whole ring been composed of such apertures, it would have been perfectly safe. Nothing, says sir Humphrey Davy, can demonstrate more decidedly than these simple facts and observations, that the interruption of flame by solid tissues permeable to light and air, depends on no recondite or mysterious cause, but to their cooling powers simply considered as such.

When light, included in a cage of wire-gauze, is introduced into an explosive atmosphere of fire-damp at rest, the maximum of heat is soon obtained, the radiating power of the wire and the cooling effects of the atmosphere, more efficient from the mixture of inflammable air, preventing it from ever arriving at a temperature equal to that of dull redness. In rapid currents of explosive mixtures of fire-damp, which heat common gauze to a high temperature, twilled gauze, in which the radiating surface is considerably greater and the circulation of air less, preserves an equal temperature. Indeed the heat communicated to the wire by combustion of the fire-damp in wire-gauze lamps is completely in the power of the manufacturer, for by diminishing the apertures, and increasing the mass of metal, or the radiating surface, it may be diminished to any extent. One important circumstance, however, is not here adverted to by sir Humphrey Davy; by increasing the thickness of the wire and diminishing the aperture, the quantity of light transmitted is greatly reduced, and its power of illumination rendered nearly inefficient. Hence the power of the manufacturer to construct a lamp perfectly safe and sufficiently luminous must be limited by certain conditions. However, sir Humphrey Davy informs us, he has lately had lamps made of thick twilled gauze formed of wires the one-fortieth of an inch, sixteen to the warp and thirty to the weft, which being rivetted to a screw cannot be displaced, from its flexibility it cannot be broken, and from its strength cannot be crushed, except by a very strong blow.

From some very ingenious experiments on the combustion of inflammable substances at low temperatures, sir Humphrey Davy discovered that a coil of platina wire, one-seventieth of an inch thick, remains at a white heat when the quantity of coal-gas is increased so as to extinguish the flame of the lamp; hence he has suggested the advantage of introducing a coil of such wire into the safety-lamp, but we do not learn that it has yet been found of practical use. An account of these experiments is given in the Phil. Trans. for 1817.

The principal objections to the use of wire-gauze safety-lamps in mines, and also to other safety-lamps, may be briefly stated; namely, the accidents to which the lamps may be unavoidably subject, and the accidents which may arise from negligence in the use of them; the injury to the health of the men, from remaining in explosive mixtures of fire-damp longer than they would have done before the introduction of these lamps into mines; and lastly, the temptation they present to neglect the more expensive methods of

ventilating mines, and trusting too much to the security of the lamp. The accidents which may happen to the lamp from one or more of the meshes being broken, when made of such slender wire, and exposed to the corrosive effects of mineral waters in the mine, or the rapid oxydation from moisture alone, must be very frequent, independently of accidents from the falling of pieces of coal on the lamp. The breaking of a single wire being sufficient to enlarge the aperture and occasion an explosion, it is obvious that extreme caution is required in the use of the lamps, and a careful inspection of them should be made every day before they are delivered to the men. This we understand is done in extensive collieries, a person being appointed for the sole purpose of inspecting and trimming the lamps. The accidents which may arise from the negligence of a single man, in extensive mines where more than fifty or one hundred persons are employed, are less easy to guard against; the lives of a great number are constantly depending on the carefulness of each person; and, however perfect the instrument may be, no one can feel perfectly safe when the air in the mine is in an explosive state. Some of the lamps were at first so constructed that they could not be opened except by the key of the inspector; but we believe this precaution is not generally introduced, the great object being to get the lamps made as cheap as possible. We conceive it, however, essential to the security of the miners, that the lamp should be closed by a lock, to prevent the men from uncovering the flame. The lamp itself, by the enlargement of the flame, gives due notice when the air of the mine is in an explosive state, and at such times the proper remedy is to be sought in ventilation; for we conceive it to be neither wise nor humane to suffer the men to remain working in an explosive atmosphere, unless under particular circumstances. Should the invention of safety-lamps induce coal proprietors to allow their workmen to remain for a longer time inhaling the fire-damp, or lead them to neglect the only permanent security, that of efficacious ventilation, we should consider the discovery as injurious to the interests of humanity. It would, however, be extremely unfair to decry the merit of any invention from the possible misuse of it. Were coal-mines first opening in a district where they had never before been worked, we believe that in most cases it would be practicable to secure a constant and safe ventilation through all the works: but in districts like those on the Tyne and the Wear, there are numerous old excavations remaining filled with impure air, of which the present miners have little knowledge, having been worked out in remote periods. Any communications accidentally opened with these old workings may suddenly fill a mine with a mixture of fire-damp, in which case the safety-lamp offers the only means of security with which we are acquainted. For viewing the old workings or *wastes* of the mine, which cannot be approached with a common lamp or candle, the safety-lamp is a most invaluable instrument; and in all cases where the steel-mill was formerly used it affords a far more secure and convenient light. Though we have thought it necessary to state the objections which may be urged against the safety-lamp, we conceive that they apply principally to the misuse of it: and the following statement made by sir Humphrey Davy offers the most satisfactory proof of its utility. "It has now been (Jan. 1817) for ten months in the hands of hundreds of common miners in the most dangerous mines in Great Britain, during which time not a single accident has occurred where it has been employed, whilst in other mines much less dangerous, where it has not been adopted, some lives have been lost, and many persons burned."

The farther experience of another year, on a more extended

tended scale, has fully confirmed the conclusions to be drawn from the above statement, and we may justly consider the safety-lamp as one of the most valuable presents which philosophy has made to the useful arts.

WIRE-Grates, in *Gardening*, are contrivances formed of fine wire-work, and used for keeping various kinds of large insects out of vineries, hot-houses, and such places, as being very mischievous to the fruit in them.

WIRE-Heels, &c. a defect and consequent disease in the feet of the horse or other animal. Some, as Gibson, think that narrow heels are for the most part a natural defect, but that they are often rendered incurable by bad shoeing. Some, in shoeing, hollow the quarters so deep and so thin, it is said, that one may almost pinch them in with one's fingers, and think by that means to widen them out by a strong broad-webbed shoe; but this turns them narrow above and *wires their heels*, and dries up or rots the frog. The best way in all such cases is, it is supposed, not to hollow the foot in shoeing, and to pare nothing out but what is rotten or foul. If the foot be hard or dry, or inclined to be ragged, it may be bathed often with chamber-ley; or two pounds of linseed bruised may be boiled in two quarts of chamber-ley to the consistence of a poultice, then adding to it six ounces of soft-soap, and the foot be softened with it every day, rubbing a little of it upon the sole; or, a composition formed of two ounces of bees'-wax, six ounces of hog's-lard, one ounce of tar, and linseed oil as much as will make it into the consistence of a smooth ointment, may be mixed together, and be used daily in the same manner as the foregoing poultice.

The diseases and affections of the feet of these animals have of late been more accurately understood, and better means of relief and cure recommended.

In the case of narrow or contracted heels, attended with inflammation, and mostly confined to the fore-feet, there is great pain; the animal is constantly moving its legs, and generally inclined to lie down. When first taken out, it is almost incapable of performing any of the paces; the weight being so much thrown on the hinder legs. In trotting, the legs are scarcely lifted above the surface of the ground; the steps are very short, and a walk or canter is gone into instead of any other pace. In the gallop, the weight of the body is thrown on the fore-part of the foot; and in trotting, on the heels; which produce very considerable pain, on account of the action of the foot being confined to the quarter in a backward direction.

The disease is mostly caused by improper shoeing, very great and hard exercise, standing in confined situations on litter, and many other such causes.

In effecting a cure in all the more fresh cases of this sort, where the variation from the natural round form of the hoof is not considerable, it may be accomplished without the animal being entirely made to rest, by removing the shoes, and if possible reducing the heels on a line with the inferior part of the frog. The sole parts may be thinned, and that portion which is between the bars of the foot and the crust be hollowed out. The hoofs should likewise be thinned with a proper tool, especially at the quarters. The shoes should not be put on again for two or three weeks in such cases, and the parts from near the coronet to the fetlock be anointed with a blistering liniment, composed of half an ounce of finely-powdered cantharides and four ounces of Barbadoes tar, well mixed together.

And when necessary, three or four pints of blood may be taken from the plate vein, and a rowel be put in the chest.

Mashes, containing nitre in the quantity of an ounce,

are to be occasionally had recourse to. At the same time, the feet of the animal should be put in a trough of warm water for two or three hours every day, so filled as just to cover the hoof-parts of them; gentle walking or trotting exercise being used on such ground as is soft.

Afterwards the shoes which are made use of should be thinner at the heels than those which were taken off, the heels resting well and firmly on the bars and crust. The patent frog may be used when the animal is at rest, as by continuing its use in a proper manner, the foot will gradually regain its natural form and action. See **FROG**.

In such cases, too, the coronet may now be bathed every day with an embrocation composed of an ounce and a half each of marsh-mallow ointment and Barbadoes tar, with half an ounce of spirit of turpentine, well incorporated together; which will promote and hasten the growth of the hoof-part of the foot.

In case the animal has been lame some length of time, and the contraction of the heels is very considerable, it should be put in moist pasture-grounds, to run for some time, carefully lowering the heels every four or five weeks, or oftener if necessary. As soon as the hoof has been elongated from the coronet to the sole, the cure will be completely effected; which will in most cases be accomplished in the course of about five months; at the end of which time the animal will have regained an entirely new circular foot of the natural shape. The animal should then be shod with thin-heeled shoes, which admit the frog-part of the foot to rest upon the ground.

In cases in which the animals cannot be turned out in this manner, they should be provided with a large shed building, well clayed on the bottom part, and preserved soft and moist by the occasional application of water slightly over it.

But though this sort of management may mostly recover and restore the natural shape of the foot, the proper action of it is not restored with such facility. In a great number of cases, the feet become so much altered in their structure and power on account of the long-continued inflammation, that the means of expansion are wholly destroyed; as is often the case in the cartilages that are situated at the higher and hinder part of the foot, which not unfrequently become bony, and, of course, it becomes impossible to regain the action of the foot. As in these cases, the more the foot is exposed, the greater will be the injury and mischief afforded; the only means of relief that can be made use of, is the covering of the foot with such a shoe as is calculated to prevent concussion, which may be accomplished by the application of a bar-shoe that will rest on every part of the crust, and not upon the frog-part of the foot. This is supposed to be the best form of shoe that can be used for the purpose.

In these cases, when the animals are at rest, the feet should be stopped with an ointment, composed of one ounce and a half each of common turpentine and tar, and two ounces and a half of mallow ointment, well mixed together.

In the cases of cracks or separations of the fibres of the hoofs in a perpendicular manner, which when they extend to the coronet are often very troublesome; the animals most liable to them, are those which have either strong brittle hoofs or narrow heels. Blood animals of the horse kind are more subject to them than others.

In the management and cure of them, the parts around the cracks should be made thin by the rasp, when the firing iron should be drawn over above and below them, to the extent of the fissures, in order to prevent their extension. It should

should likewise be carried over the cracks, by which means a slight quantity of tenacious moisture will exude, and glue up the separated parts; which may be covered over with an ointment composed of four ounces of marsh-mallow ointment, and two ounces of common turpentine, spread upon tow, and kept on the parts by bandages.

The animals should have bar-shoes, which may rest firmly on the frogs, and be made hollow in the parts opposite to the seats of the complaints, in order that no pressure may be given to those parts of the feet; rest being given for some days, and then only moderate exercise allowed, until the cracks have descended towards the lower parts of the feet. The coronets and hoofs may be bathed twice a day, as in the above cases of contracted heels, in order that the growth of horn may be promoted. By the use of these means, the animals mostly soon get better.

WIRES of Asteria, in *Natural History*, a name given by authors to a sort of extraneous fossil belonging to the *asteria*, and being a sort of branches from the body of that column.

WIRE of Lapland. The savage inhabitants of Lapland have a sort of shining slender substance in use among them on several occasions, which is much of the thickness and appearance of our silver wire; and is therefore called, by those who do not examine its structure or substance, *Lapland wire*.

The people of this miserable country find many uses in every thing nature has afforded them, and, among the rest, that species of stag called the rein-deer, which is the most frequent animal among them, is not only serviceable in furnishing them with meat, clothes, houses, and the means of carriage and travelling; but its bones make many of their most necessary utensils; and the sinews, which are all carefully separated in the eating, are, by the women, after soaking in water, and beating, spun into a sort of thread, which is of admirable fineness and strength, when wrought to the smallest filaments; but when larger, is very strong, and fit for the purposes of strength and force. Their wire, as it is called, is made of the finest of these threads, covered with tin. The women do this business, and the way they take is to melt a piece of tin, and placing at the edge of it a horn with a hole through it, they draw these finewy threads, covered with the tin, through the hole, which prevents their coming out too thickly covered. This drawing is performed with their teeth, and there is a small piece of bone placed at the top of the hole, where the wire is made flat, so that we always find it rounded on all sides but one, where it is flat.

This wire they use in embroidering their clothes as we do with gold and silver; and they often sell it to strangers, under the notion of its having certain magical virtues. Scheffer, Hist. Lapland.

WIRE-Worm, in *Agriculture*, a most mischievous worm in different sorts of grain-crops. It has been described by Bierkander, in the Swedish Transactions, as having in the grub-state a yellow colour, with the head brown, and the extremities of the jaws black; the body constituted of twelve joints, shining, and hard-skinned; when it changes its skin it is for some time white; a few hairs are scattered here and there, but mostly upon the head and last joint; under the three first joints are six horny and pointed feet, and at the beginning of the last joint, which is round, there are two black spots, one on each side, which are, probably, apertures through which it breathes.

It is considered by some, notwithstanding the almost general opinion of farmers to the contrary, that the disease

of wheat-crops, which is attributed to this insect or worm, depends upon some other cause, as a fault in ploughing, by which the land is left in too light, open, and porous a state or condition, and which prevents the young plants from being fully and properly nourished, and consequently from forming their roots in a proper manner in the ground. And this notion is in some measure supported by the circumstance of the benefit which is afforded by rolling, treading, and otherwise compressing the land.

It has been proved and shewn by many different trials, that this worm is one which is extremely tenacious of life, and consequently not easily destroyed or got quit of by any means which have yet been made use of for the purpose.

WIRE, in *Geography*, one of the smaller Orkney islands, separated from Rousa by a strait called Wire Sound, about three-quarters of a mile in breadth. N. lat. 58° 58'. W. long. 2° 51'.

WIRE. See *WYRE*.

WIREDY, a town of Sweden, in the province of Smaland; 16 miles N.E. of Jonkioping.

WIRESTA, a town of Sweden, in the province of Smaland; 26 miles S.W. of Wexio.

WIRI, two small islands in the gulf of Finland. N. lat. 59° 50'. E. long. 27°.

WIRING, among *Animals*, the operation of putting a sharp-pointed wire up the nostrils of a sheep, so as to pass up into the brain, and produce a discharge in cases of the sturdy, turn, gid, or vertigo. It seems, however, a dangerous remedy, though it is said to have been successful in curing the disease in many cases.

WIRING Fruit-Trees, in *Gardening*, the operation and practice of passing a fine wire round their branches, in order to bring on the fruiting state.

WIRKOWENES, in *Geography*, a town of Poland, in the palatinate of Kiev; 44 miles W.N.W. of Biala-cerkiew.

WIRKSWORTH, an ancient market-town in the wapentake of the same name, in the county of Derby, England, is situated near the southern extremity of the mining district, in a valley nearly surrounded by hills, at the distance of 14 miles N.N.W. from the county-town, and 140 miles N.W. by N. from London. In the year 835, the manor belonged to the abbey of Repton; after the destruction of that monastery by the Danes, it became vested in the crown, to which it appertained at the time of taking the Domesday-survey. King John granted it to William de Ferrars, earl of Derby. Having been forfeited by the attainder of earl Robert in 1265, it was granted, together with the wapentake, by Edward I. to his brother, Edmund, earl of Lancaster; and has ever since formed part of the earldom or duchy of Lancaster. It is now held under the duchy by Richard Arkwright, esq. A market on Wednesdays, and a fair of three days, were granted for this town to Thomas, earl of Lancaster, in 1305. The market is now held on Tuesday, chiefly for butcher's-meat, butter, eggs, and pedlar's-ware: the corn-market is small. Four annual fairs are now held. The town-hall, a handsome brick structure, was built in 1773, by the direction of Thomas, lord Hyde, the chancellor of the duchy. In this hall are held courts-baron for the manor, courts-leet for the wapentake, and barmote-courts for regulating the mines and mineral concerns. The church, a spacious edifice, apparently of the fourteenth century, consists of a nave and side-aisles, a north and south transept, a chancel, and a square tower, supported by four large pillars. In the church-yard is a grammar-school, founded in 1576, by Anthony

Anthony Gell, esq. who endowed it with lands which now produce 17*ol. per annum*. He also founded an alms-house for six poor men, to which he gave a rent-charge of 2*ol.*; this has been augmented by subsequent benefactions. In the town was formerly a meeting-house for Presbyterians, but it is now occupied by a congregation of Independents. Here are also chapels for Baptists and Wesleyan Methodists. In the population return of the year 1811, the inhabitants of this town are enumerated at 3474, occupying 777 houses. The parish of Wirksworth is extensive, and includes, besides the town, fourteen townships or villages, some of which are very populous.—*Beauties of England and Wales*, vol. iii. Derbyshire. By J. Britton and E. W. Brayley, 1803. *Lynons' Magna Britannia*, vol. v. Derbyshire, 1817.

WIRNAU, a town of the county of Henneberg; 5 miles S.E. of Smalkalden.

WIRRAL, or WIREHALL, a strip of land in the county of Chester, extending from the city of Chester to the sea, between the rivers Dee and Mersey.

WIRREY, or ST. ANDREW, one of the Shaint islands. N. lat. 57° 53'. W. long. 6° 19'.

WIRSRUM, a town of Sweden, in the province of Smaland; 46 miles N.N.W. of Calmar.

WIRSTBERGHOTZEN, a town of Westphalia, in the bishopric of Hildesheim; 8 miles S. of Hildesheim.

WIRSUNG, JOHN GEORGE, in *Biography*, was a native of Bavaria, studied medicine at Padua, and was a disciple of Vesling. In 1642 he published the discovery of the pancreatic duct, with which his name is connected; and in the following year he was assassinated by a Dalmatian, under the influence of a passion excited by having been silenced by him in a public disputation. Haller. Eloy.

WISANGI, in *Geography*, a town of Sweden, in West Bothnia, on the Tornea; 95 miles N.N.W. of Tornea.

WISBADEN, a town of Germany, in the principality of Nassau Saarbruck Ufingen. This town was known to the Romans, and the *Heidenische Maur*, or *Heathen Wall*, which runs through the present town of Wisbaden, appears to be a work of that nation; and a part of the boundaries of this town are derived from the lined trenches thrown up by Drusus, opposite to Mentz, for the covering of the Rhine. In the days of the kings of the Franks, in this town was a royal court. At Wisbaden are some medicinal springs, formerly in great repute; 5 miles N.W. of Mentz. N. lat. 50° 3'. E. long. 8° 9'.

WISBECH, a large market-town in the county of Cambridge, England, gives name to a hundred and a deanery, and is situated in the extreme northern part of the county, about 30 miles N. from Ely, 42 from Cambridge, and 90 from London, in the same direction. Wisbech is a great mart for corn, about 100,000 quarters being annually exported from thence by the river Ouse, and the canals communicating with Cambridge, Lynn, and other towns. Other articles of export are rape-seed and long wool, of which great quantities are sent to the Yorkshire clothiers. Timber, from Northamptonshire, is also embarked for the service of the navy. The principal imports are, coals, deals, and wine. The river is navigable up to Wisbech, at spring-tides, flowing six or eight feet, for vessels of 60 tons, which are constantly employed in the corn trade, to London, Hull, and other ports. Prior to the Norman Conquest, Wisbech belonged to the convent of Ely. In 1071 William of Normandy erected a castle of stone at the town;

but this being dismantled, a new castle of brick was built on the scite, between 1478 and 1483, by Morton, bishop of Ely, and which became the episcopal residence. Being purchased by secretary Thurloe during the interregnum, it was rebuilt after designs by Inigo Jones. Reverting at the Restoration to the see of Ely, it was sold some years ago, and on the ground of the detached buildings some good houses have been erected. The church is a spacious, handsome fabric, although of a singular construction, having two naves and two aisles. The naves are lofty, and separated by light slender pillars, with pointed arches; the aisles, which are the most ancient, are divided from their respective naves by low massy pillars and semicircular arches. The tower of the church is beautiful, and notwithstanding the antiquity attributed to it, is proved by records to have been erected posterior to 1520. Wisbech, with the adjacent country, has frequently suffered by inundations, particularly in 1236, when great numbers of small craft, cattle, and men, were destroyed. In 1437, by a breach in the bank of Wisbech fen, upwards of 4000 acres of land were overflowed. But the greatest devastations of this kind occurred in Nov. 1613, by the spring-tide concurring with a violent N.E. wind; and in March 1614, by the melting of the snow in the country. In 1611 the inhabitants obtained a renewal of their charter, which constituted them a body corporate, by the style of the burgesses of Wisbech; but the right of the election of the ten capital burgesses was limited to the possessors of freeholds of the value of 40*s. per annum*. The executive officer, the town-bailiff, although a person wholly unknown to the charter, has the entire management of the estates and affairs of the corporation. The annual income under the management of these capital burgesses, allotted to public and charitable purposes, amounts to about 800*l.* A principal object of this charge is the maintaining of beacons and buoys, and the clearing of the channel of the river Ouse or Wis, from which the town takes its name; precautions highly necessary, on account of the shifting sands between the town and the sea. Among the improvements made in Wisbech of late years, must be mentioned the stone bridge of one elliptic arch, and the new custom-house. The streets are paved, lighted, and watched, at the expense of the corporation. The trade of Wisbech has much increased of late years, through the improved state of the drainage and navigation of the fens. The neighbouring lands are in high cultivation, and are chiefly appropriated to grazing. The sheep and oxen grow to a great size; and considerable numbers are sent off twice every week to London. The inhabitants are almost wholly employed in commerce, the town possessing no kind of manufacture, although the surrounding country produces vast quantities of wool, hemp, and flax. The canal, opened not many years ago, extending from Wisbech river to the river Nene at Outwell, and thence to the Ouse, affords a communication with Norfolk, Suffolk, and the western counties, and which proves very beneficial to the town. In 1781 a literary society was established in Wisbech, and the education of youth is provided for by a free-school, and by two charity-schools, supported by subscription. The dissenters from the established church are not numerous, but have their respective places of worship. The parish, containing 6308 acres, is in the greatest part a very rich arable and pasture land. In 1676 the inhabitants of Wisbech were computed to be 1705; in 1801 they amounted to 5004; and in 1811 to 6300: the inhabited houses were 1237.—*Beauties of England; Cambridgehire*. By J. Britton and E. W. Brayley, 8vo. 1802. *Magna Britannia*, by the Rev. D. Lyfons and S. Lyfons, 4to. 1808.

WISBERG, a town of Germany, in the principality of Culmbach; 8 miles E. of Culmbach.

WISBY, a town of Sweden, on the west coast of the island of Gothland. This is a very ancient staple, and in former times one of the Hanse towns. When Wineta, a place of great trade in the island of Ufedom, near the coast of Pomerania, was destroyed by an inundation, several of its wealthiest inhabitants removed to Wisby. It was likewise frequented by Swedes, Goths, Danes, Normans, French, English, Saxons, Livonians, Spaniards, Russians, Greeks, and other nations. The maritime laws of Wisby were famous in all parts, and adopted along the coast of the Baltic. (See *INSURANCE*.) The wall of Wisby, and the towers with which it is flanked, were built in the year 1289. This town continued in a flourishing condition till the year 1361, when the Danes almost totally destroyed it. The harbour is safe and commodious, but not very large. N. lat. 57° 38'. E. long. 18° 18'.

WISCASSET, a sea-port town of America, in the province of Maine, in the county of Lincoln, on the Sheep cut, with 2083 inhabitants; 30 miles N.E. of Brunswick.

WISCHAU, or **WISKAU**, a town of Moravia, in the circle of Brunn; 15 miles E. of Brunn. N. lat. 49° 17'. E. long. 16° 54'.

WISCHBACH, or **FISCHBACH**, a town of the duchy of Stiria; 5 miles S. of Muertzenschlag.

WISCHGROD, a town of the duchy of Warsaw, on the Vistula; 27 miles S.E. of Poloczko.

WISCHITEN, a town of Lithuania, in the palatinate of Troki; 70 miles W. of Troki.

WISCHKOWA, a town of Bohemia, in the circle of Saatz; 5 miles N.N.E. of Saatz.

WISCHNOWA, a town of Bohemia, in the circle of Beraun; 3 miles E. of Przbiram.

WISDIM, a town of Bohemia, in the circle of Boleslaw; 14 miles W.N.W. of Jung Buntzel.

WISDOM, **SAPIENCE**, usually denotes a higher and more refined knowledge of things, immediately presented to the mind, as it were by intuition, without the assistance of ratiocination.

In this sense, wisdom may be said to be a faculty of the mind, or at least a modification and habit of it.

Sometimes the word is more immediately used in a moral sense, for what we call *prudence* or *discretion*; which consists in the soundness of the judgment, and a conduct answerable to it.

The school-divines sometimes restrain wisdom to the knowledge of the more sublime and remote objects, as that of God, &c. In which sense, theology is properly said to be wisdom.

The Latin word for wisdom is *sapientia*, which literally expresses the sense of tasting; to which wisdom is supposed to have some conformity. The sight, and other senses, only represent to us the surface of things: taste goes deeper, and penetrates into the substances; so that what, *e. gr.* to the feeling seemed cold, to the taste will be found hot: so wisdom, arising from a deep attention to our ideas, goes farther, and frequently judges otherwise than the common apprehensions of men would reach to.

WISE, **MICHAEL**, in *Biography*, an admirable composer for the church, fostered in the Chapel Royal after the Restoration, under captain Henry Cook, at the same time as Humphrey and Blow, three musicians, who not only far surpassed their master in genius and abilities, but all our church composers of the 17th century, except Purcell. However, they prepared the way for his bold and original

genius to expand; as several new melodies, modulations, and happy licences, which we used to think entirely of his invention, upon an attentive examination of their works, appear to have been first suggested by these three fellow-students. Yet, what they had slightly and timidly touched, Purcell treated with the force and courage of a Michael Angelo, whose abilities rendered the difficult easy, and gave to what, in less powerful hands, would have been distortion, facility, and grace.

Dr. Boyce has printed six verse and full anthems, by Wife, which are admirable; and in Dr. Tudway's collection, Brit. Mus., there are seven more, and a whole service in D minor.

He was author of the celebrated two-part song, "Old Chiron thus preached to his pupil Achilles," which is still too well known to need an encomium here.

Michael Wife was killed in a street-fray at Salisbury, by the watchman, in 1687.

The first movement of his verse-anthem for two voices, "The ways of Zion do mourn," is more beautiful and expressive than any grave and pathetic composition for the church of other countries, of the same kind and period of time, that we have hitherto discovered.

The use which the author has made of chromatic intervals at the word *mourn*, is not only happy and masterly, but *new*, even now, at more than a hundred and twenty years distance from the time when the anthem was produced! The whole composition seems to us admirable; and besides the intelligence and merit of the design, the melody is truly plaintive, and capable of the most touching and elegant expression of the greatest fingers of modern times; the harmony too and modulation are such as correspond with the sense of the words, and enforce their expression.

There is an elegance of phrase in a passage of the second movement of the preceding anthem, at the word *down*, which has been lately revived, and in great favour, with a very minute difference, among the first fingers of Italy. The difference consists only in pointing the first note if a crotchet or quaver, and making the second and third notes semiquavers or demisemiquavers.

Wife was a native of Salisbury, in which cathedral he was appointed organist and master of the choristers, in 1668; and in 1675, a gentleman of the chapel royal. In 1686, he was preferred to the place of almoner and master of the boys at St. Paul's. He is said to have been in great favour with Charles II., and being appointed to attend him in a progress, claimed, as king's organist for the time, the privilege of playing to his majesty on the organ, at whatever church he went.

Wise Men of Greece, *Seven*, in the *History of Philosophy*, an appellation given to several eminent men, on whom was bestowed the praise of civil and moral wisdom. The history of these persons, originally without doubt plain and simple, has been rendered obscure and uncertain by traditionary reports. The incident to which this appellation was at first owing was as follows:

In the third year of the 49th Olympiad, it happened that certain youths of Ionia, purchasing from a fisherman of Miletus a large draught of fish, which he had brought to shore, found in the net a golden tripod of great value. Upon this a dispute arose between the fisherman and the purchasers: the former maintaining that he had only sold them the capture of fish; the latter asserting that they had bought the chance of the draught, whatever it might be. The question was referred to the citizens of Miletus, who were of opinion, that in an affair so extraordinary, the Delphic oracle

oracle should be consulted. The answer of the oracle was 'To the Wisest.' In obedience to this answer, the Milesians unanimously adjudged the tripod to Thales. Thales modestly declined the honour intended him by his fellow-citizens, and sent the tripod to Bias, a wise man of Priene; from him it was passed on through several hands, till it came to Solon, the Athenian legislator, who judging that the character of 'the wisest' could not properly belong to any human being, sent the prize of wisdom to Delphos to be dedicated to Apollo. The story, as above related, has in it something fabulous; and the circumstances that attend it are differently related by different writers. It is more probable, says Brucker, that in some public assembly a tripod was proposed as an honorary prize to the man who should recite, in verse, the most excellent maxims of political and moral wisdom, and that the sages who engaged in this generous contest afterwards agreed to dedicate the prize to Apollo. In confirmation of this conjecture it is alleged, from a passage in Plato's Protagoras, that the wise men of this period met together to frame concise precepts and maxims for the conduct of life, and agreed to send such sentences as were thought most valuable to Delphos, to be inscribed in the temple. Hence Apollo is said by the ancients to have been the author of the precept 'Know thyself.'—'E cælo descendit, Γνωθὶ σεαυτὸν.' The names commonly included under the appellation of the Seven Wise Men of Greece are, Thales, Solon, Chilo, Pittacus, Bias, Cleobulus, and Periander. Brucker's *Philos.* by Enfield, vol. i.

WISECK, in *Geography*, a river of Hesse, which runs into the Lahn, near Giessen.

WISELL, a town of the duchy of Stiria; 4 miles N.E. of Rein.

WISEMAN, RICHARD, in *Biography*, was first known as a surgeon in the civil wars of Charles I., and accompanied prince Charles, when a fugitive, in France, Holland, and Flanders. He served for three years in the Spanish navy, and returned with the prince to Scotland, and was made prisoner in the battle of Worcester. After his liberation, in 1652, he settled in London. When Charles II. was restored, he became eminent in his profession, and was made one of the serjeant-surgeons to the king. In May 1676 he appears, from the preface to his works, to have been a sufferer by ill health for twenty years; but the time of his death is not known. The result of his experience appears in "Several Chirurgical Treatises," fol. 1676, 1686, and in 2 vols. 8vo. 1719. The subjects of these treatises are, tumours, ulcers, diseases of the anus, king's-evil, wounds, gunshot-wounds, fractures and luxations, and lues venerea. The course of his practice comprehended more than 600 cases, of which he gives apparently an honest account, recording his failures as well as his cures, and the detail merits attention. In his relation of the miraculous effects of the royal touch in scrofula, it is not easy to reconcile his honesty with his sagacity, though from his own narration, duly considered, the fallacy is easily detected. His writings have long been regarded as standard authority in the examinations at Surgeon's-Hall. *Gen. Biog.*

WISEMAN, Mr., a worthy English musician, who went early in life to Italy, in order to receive lessons on the violin from Tartini, in Padua, who recommended him, in 1736, to one of his favourite scholars, Pasqualino Bini, at Rome, where, after some time, finding himself likely to thrive as a professor, by the patronage of the English nobility and gentry with which that city always abounds in their travels, settled there for the rest of his life; and though not a performer of the first class, being a good

musician, and a man of probity and good conduct, he was not only respected by his countrymen, but by the natives of that city, which, though no longer the capital of the world, is still the capital of Italy and the fine arts.

Mr. Wiseman had resided so long in Italy, that he had almost forgotten his native tongue. In 1770 he lived in the Palazzo Rafaele, without the gates of Rome, where, during the first winter months, he had a weekly concert till the operas began. It was here that the great Raphael lived and died, where there were still some of his paintings in fresco, and where the late duke of York, the prince of Brunswick, and several other great personages, gave concerts to the first people of Rome.

WISEN, in *Geography*, a river of Baden, which runs into the Rhine, near Bâle.

WISENT, a river of Bavaria, which runs into the Rednitz, near Forcheim, in the bishopric of Bamberg.

WISEPPE, a town of France, in the department of the Meuse; 3 miles S. of Stenay.

WISFTARDA, a town of Sweden, in the province of Smaland; 22 miles N. of Carlscrona.

WISHART'S ISLAND, an island in the Pacific ocean. This is one of the Solomon islands, and by the Spaniards called Artreguada. S. lat. 2° 20'. E. long. 150° 55'.

WISIR, a small island in the East Indian sea, near the west coast of Aroo. S. lat. 15° 21'. E. long. 134° 51'.

WISK, or **WIRSK**, a river of England, in the county of York, which runs into the Swale.

WISKA, a river of Sweden, which runs into the sea, 3 miles S. of Waro, in West Gothland.

WISKI, a town of Bohemia, in the circle of Beraun; 4 miles N. of Przibram.

WISLAUFF, a river of Wurtemberg, which runs into the Rems, N.E. of Schorndorff.

WISLITZA, a town of Poland, in the palatinate of Sandomirz; 48 miles W.S.W. of Sandomirz.

WISLOCH, a town of the duchy of Baden, in the palatinate of the Rhine; 14 miles E. of Spire. N. lat. 49° 18'. E. long. 8° 45'.

WISMAR, a town of the duchy of Mecklenburg, situated in a bay of the Baltic, with a good harbour; large, well fortified, and defended by a citadel. This is one of the best and largest places in the country; as, besides six churches, it has also a particular consistory of its own, with a grammar-school, under the direction of eight masters, and is the seat of a Swedish court of justice, erected in the year 1653, both for the district and Swedish Anterior Pomerania. The court consists of a president, a vice-president, and four assessors. It was formerly a Hanse town, and possessed of the privilege of coining; the first origin is not known with any degree of certainty. In the year 1238, it was enlarged; and in the year 1266, obtained the Lubeck rights. In the year 1261, it was annexed to the duchy of Schwerin; in the year 1627, the Imperialists got possession of it; but in the year 1632 were driven out by the Swedes, to whom it was ceded, at the peace of Westphalia, in 1648; 33 miles E. of Lubeck. N. lat. 53° 55'. E. long. 11° 26'.

WISMATH, a town of Austria; 14 miles S. of Ebenfurth.

WISNA, a town of the duchy of Warsaw; 70 miles N.E. of Warsaw.

WISNUM, a town of Sweden, in the province of Warmeland; 25 miles E.N.E. of Carlstadt.

WISOKIA, a town of Lithuania; 20 miles N.N.W. of Brzesc.

WISP, in *Rural Economy*, a term signifying a small bunch of

of straw which is used in rubbing horses down. Wisp is also a term sometimes applied to a rowel or feton put in animals.

WISPEL, in *Commerce*, a corn measure in Germany. A last of wheat contains 3 wispels; and a last of oats only 2 wispels. See **SCHEFFEL**.

WISSANT, in *Geography*, a town of France, in the department of the fraits of Calais; 12 miles N. of Boulogne.

WISSING, WILLIAM, in *Biography*, was born at Amsterdam in 1656. He received instructions in the art of painting from Dondyns, an historical painter at the Hague, but on leaving that master went to Paris, and in the year 1680, came to England, and assisted Lely in his numerous works. After Lely's death, he became rather a favourite, and promised to become a formidable rival to Kneller. He drew all the royal family, and was particularly favoured by the duke of Monmouth, whose portrait he painted several times. The duke of Somers set also patronized him, and employed him to paint himself and his duchess, and the pictures are now at Petworth.

Wissing was appointed principal painter to James II., and was sent by him into Holland, to paint portraits of William and Mary. He did not long survive his return to England, and died at Burleigh, the seat of the earl of Exeter, in 1687, at the age of 31. His heads were painted with softness and delicacy, in a style quite distinct from that of his master, Lely, or his rival, Kneller; too soft, indeed, for character; and his larger pictures lack composition and harmony, both in line and colour.

WISSOKY-MEYTO, in *Geography*. See **HOHENMAUT**.

WISSOWATIUS, ANDREW, in *Biography*, a Socinian divine, was born of a noble family in Lithuania, in 1608, educated in the New Unitarian college at Racow under Crellius, and for some time pursued his studies at Leyden, strictly adhering to the principles of his tutor. Finding, on his return to Poland, that his brethren suffered persecution from the diet of Warsaw, he exerted himself courageously in their defence, and encountered many personal difficulties and sufferings in the exercise of his ministry in various parts of Poland. He was not silenced by the decree issued against Unitarians in 1658, but leading an unsettled life, he was industrious in seizing every opportunity that occurred for making proselytes. In 1660, he was the only person of his party who was present at the "Colloquium Charitativum," where he firmly maintained his opinions against the jesuit Chichovius and others. He is said to have resisted large bribes, as well as to have encountered severe trials, in maintaining his sentiments. Removing to Hungary, he spent two years in learning the language so as to be able to instruct and fortify his brethren in that kingdom. Last of all he retreated to Holland, where he was employed in superintending an edition of the "Bibliotheca Fratrum Polonorum," in 9 vols. fol., and where he died in 1678. His integrity and constancy are highly applauded by the historians of his sect; his writings were numerous, and one of them, published after his death, was entitled "Religio rationalis, seu de Rationis judicio in controversiis, etiam theologiacis ac religiosis adhibendo, tractatus." Gen. Biog.

WISSOWITZ, in *Geography*, a town of Moravia, in the circle of Hradisch; 20 miles E.N.E. of Hradisch.

WIST, WISTA, a quantity or measure of land among our Saxon ancestors; of different dimensions, in different places. In the Monasticon, it is said to be half a hide, or sixty acres: in an old chronicle of the monastery of Battle, it is said to be forty-eight acres.

WIST, in *Geography*, a town of Sweden, in the province of East Gothland; 6 miles S.S.E. of Linköping.

WISTE, a town of the duchy of Bremen; 10 miles S.W. of Bremen.

WISTE, a river of the duchy of Bremen, which runs into the Wumme, 1 mile E. of Ottersberg.

WISTERNITZ, a town of Moravia, in the circle of Olmutz; 4 miles E. of Olmutz.

WISTERNITZ, *Unter*, a town of Moravia, in the circle of Brunn; 22 miles S. of Brunn.

WISTON, or **WIZTON**, a town in the hundred of Dan-gladdan, county of Pembroke, South Wales, at the distance of 5 miles N.E. by E. from Haverford West. It is a contributory borough with Pembroke and Tenby in sending one member to parliament, and is governed by a mayor. The parish contains about 6000 acres: and in the return of the year 1811, the population was enumerated as 607 persons, occupying 103 houses. An annual fair is held on the 8th of November. In ancient times here was a castle of great extent; but it is now in ruins.—Carlisle's Topographical Dictionary of Wales, 4to. 1811.

WISTRIZ, or **WESSERIZ**, a river of Bohemia, which runs into the Egra, 3 miles E. of Schlackenwerth.

WISTYCZA, a town of Lithuania; 5 miles N. of Brzesc.

WISZOGZOD, a town of the duchy of Warsaw; 52 miles N.W. of Warsaw.

WIT, DE, in *Biography*. There were several painters of this name very respectable in their profession. Peter Candido de Wit, born at Bruges in 1548, went to Italy, and became a friend and co-labourer with G. Vasari. He was afterwards employed by the grand duke of Tuscany at Florence, and painted in oil and fresco. The emperor Maximilian invited him to Munich, and there he terminated his career. Gasper de Wit, his brother, painted small landscapes very highly finished, in which he introduced Italian architectural ruins. Of later date was Emanuel de Wit, born at Alkmaer in 1607, and a painter of still life. He afterwards became a painter of architecture and perspective views of churches, &c. which were touched with great clearness, animation, and spirit. He died in 1692. Another of the name, Jacob de Wit, is the flower of the flock. He was born at Amsterdam in 1695, and having exhibited a desire for the pursuit of art, was placed with Van Spiers, an historical painter, for three years. He afterwards went to Antwerp to contemplate the admirable productions of Rubens and Vandyke, which adorned that city; and there he became the pupil of Jacob van Halen, continuing with him two years.

To him we are indebted for the preservation of the composition made by Rubens for four ceilings, divided into thirty-six compartments, in the church of the Jesuits, which was destroyed by lightning in 1718. They have been since engraved from de Wit's sketches by John Prout.

He was principally employed in adorning ceilings and the walls of apartments; and generally chose allegorical and emblematical subjects, which he composed with considerable ingenuity, and coloured in a clear and pleasing manner. He was employed by the magistrates of Amsterdam, in 1736, to adorn their great council-chamber; and his work has had the honour of being applauded by sir J. Reynolds. His sketches for his larger works are touched with great freedom and neatness, and with good colour. He was living in 1744.

WIT, a faculty of the mind, consisting, according to Mr. Locke, in the assembling and putting together of those ideas with quickness and variety, wherein can be found any resemblance or congruity; by which to make up pleasant pictures, and agreeable visions, in the fancy.

This faculty, the same great author observes, is just the contrary of *judgment*, which consists in the separating carefully from one another, of such ideas wherein can be found

the least difference, thereby to avoid being misled by similitude, and, by affinity, to take one thing for another: and hence he accounts for the reason of that common observation, that men who have much wit and prompt memories, have not always the clearest judgment, or deepest reason.

It is the metaphor and allusion wherein, for the most part, consist the entertainment and pleasantries of wit; which strikes in so lively a manner on the fancy, and is therefore so acceptable to all people, because its beauty appears at first sight, and there is required no labour of thought, to examine what truth or reason there is in it. The mind, without looking any farther, rests satisfied with the agreeableness of the picture, and the gaiety of the imagination; and it is a kind of affront to go about to examine it by the severe rules of truth, or reason. Whence it should seem, that wit consists in something that is not perfectly conformable to them. *Essay on Human Understanding*. b. ii. c. xi. s. 2.

Professor Dugald Stewart (*Elem. of the Philosophy of the Human Mind*, p. 302.) adds to Locke's definition of wit, that it implies a power of calling up at pleasure the ideas which it combines; and he inclines to believe, that the entertainment which it gives to the hearer is founded, in a considerable degree, on his surprise, at the command which the man of wit has acquired over a part of the constitution, which is so little subject to the will. Hence it is, that we are more pleased with a *bon mot* which occurs in conversation than with one in print; and that we never fail to receive disgust from wit, when we suspect it to be premeditated. The pleasure, too, which we receive from wit, is heightened, when the original idea is started by one person, and the related idea by another. Accordingly Dr. Campbell has remarked, that a witty repartee is infinitely more pleasing than a witty attack; and that an allusion will appear excellent when thrown out extempore in conversation, which would be deemed execrable in print.

To the same purpose another ingenious writer has observed upon Mr. Locke's description of wit, that every resemblance of ideas is not that which we call wit, unless it be such an one that gives delight and surprise. These two properties, he says, seem essential to wit, more particularly the latter of them. In order, therefore, that the resemblance in the ideas be wit, it is necessary they should not lie too near one another in the nature of things; for where the likeness is obvious, it gives no surprise. *Spectator*, vol. i. N^o 62.

From this account of the nature of wit, it is easy to perceive what good reason Cicero had for saying (*De Orat. lib. ii. cap. 54.*) *Wit is a thing not to be learned*: it is the offspring of nature, and proper effect of a bright and lively fancy. Cicero reduces wit to two kinds, *viz. cavillatio*, which, in our language, may be called *continued wit*, or humour, and *dicacitas*, which may be termed *concise wit*, or jesting.

The ingenious professor above cited suggests the following difference between invention in the arts and sciences and wit. The former depends, in most instances, on a combination of those ideas which are connected by the less obvious principles of association; and it may be called forth in almost any mind by the pressure of external circumstances. The ideas which must be combined in order to produce the latter are chiefly such as are associated by those slighter connections which take place when the mind is careless and disengaged. "If you have real wit," says lord Chesterfield, "it will flow spontaneously, and you need not aim at it; for in that case, the rule of the gospel is reversed; and it will prove, Seek and you shall not find." Accordingly wit is promoted by a certain degree of intoxication, which prevents the exercise of that attention which is necessary for invention in matters of science.

For the nature of wit in general, the different kinds of it, its use to an orator, and the manner in which it ought to be conducted, see Ward's *Orat.* vol. ii. p. 195, &c.

WIT is also an appellation given to persons possessed of the faculty called *wit, esprit*.

A French author, who, in 1695, published a "Treatise of Wit, du Bel Esprit," lays down four characters of it.

1. A man, who, with an open air and easy motions, affects those he converses with agreeably; and on any subject that presents itself, advances new thoughts, and adorns them with a sprightly turn; is, all the world over, a wit.

2. Another, who, less solicitous about the choice and delicacy of his sentiments, knows how to make himself valued by I know not what elevation of discourse; who draws much attention, and shews great vivacity in his speaking, and readiness in his answers; is likewise acknowledged a wit.

3. A third, who takes less care about thinking than about speaking well: who affects fine words, though perhaps low and poor in matter; who pleases by an easy pronunciation, and a certain tone of voice, is placed in the same rank.

4. Another, whose chief aim is not to make himself esteemed, so much as to raise mirth and laughter; who jokes pertinently, rallies pleasantly, and finds something to amuse himself with in every petty subject; is likewise allowed a wit.

Yet, it may be observed, that in all these cases, there is nothing of real wit, as above defined; but the whole is *imagination*, or *memory* at most: nay the whole is no more than what temperament may give.

A true wit must have a just faculty of discernment; must have, at the same time, both great energy, and peculiar delicacy, in his sentiments; his imagination must be noble, and at the same time happy and agreeable; his expressions polite and well turned; without any thing of parade or vanity in his discourse, or his carriage. It is not at all essential to a wit, to be ever hunting after the brilliant; still studying fine thoughts, and affecting to say nothing but what may strike and surprise.

This is a fault very frequent in dramatic persons: the duke of Buckingham rallies it very justly.

"What is that thing which we sheer wit do call?
'Tis when the wit of some great writer shall
So overflow, that is, be none at all,
That ev'n his fools speak sense —."

From the account we have given in the preceding article of the difference between invention and wit, it appears, that those who have the reputation of wits are commonly more confident in their own powers, who allow the train of their ideas to follow, in a great measure, its natural course, and hazard in company every thing, good or bad, which occurs to them. Men of modesty and taste seldom attempt wit in a promiscuous society; or if they are forced to make such an exertion, they are seldom successful. Such men, however, in the circle of their friends, to whom they can unbosom themselves without reserve, are frequently the most amusing and the most interesting of companions; as the vivacity of their wit is tempered by a correct judgment and refined manners: and as its effect is heightened by that sensibility and delicacy, with which we so rarely find it accompanied in the common intercourse of life. When a man of wit makes an exertion to distinguish himself, his sallies are commonly too far-fetched to please. He brings his mind into a state approaching that of the inventor, and becomes rather ingenious than witty.

Genuine wit, says lord Chesterfield, never made any man laugh since the creation of the world: upon which profess-

for Stewart remarks, that this observation is just, if by genuine wit we mean wit wholly divested of every mixture of humour; and if by laughter we mean that convulsive and noisy agitation which is excited by the ludicrous. But there is unquestionably a smile appropriated to the flashes of wit; — a smile of surprise and wonder: — not altogether unlike the effect produced on the mind and the countenance by a feat of legerdemain when executed with uncommon excess.

Humour, say our critics, is the genuine wit of comedy.

WIT, *Child*. See CHILD-WIT.

WIT-FISH, in *Ichthyology*, a name given by the Dutch in the East Indies to a fish common on those coasts, and seeming to be of the tania kind. It is of the size of our common whiting. Its back is straight and even, and its belly prominent; its snout is pointed somewhat upwards, and tail forked. It has one single spine or prickle on its back, and has a long belly-fin reaching from the head to near the tail; its whole body is friated, and it has two long filaments or beards hanging from its snout, and is a very fine and delicate fish. Ray.

WIT-FISH is also the name given by the Dutch to an East Indian fish, called by Mr. Ray, *Albula Indica*.

WITASARI, in *Geography*, a town of Sweden, in Tavastland; 70 miles N.N.E. of Jamsio.

WITCH of *Endor*, in *Biblical History*, a woman who had a familiar spirit, and who was employed by Saul to consult the deceased Samuel concerning the issue of his contest with the Philistines. See 1 Sam. xxviii.

The explication of this part of sacred history has greatly perplexed commentators and critics. Some, in deference to the authority of the ancient fathers of the Christian church, who ascribed to magicians and necromancers the power of calling up the souls of the dead, have given a literal interpretation of this history, and supposed that Samuel actually appeared to Saul. But to this opinion it has been justly objected, that it is repugnant to the order of the natural world, and to the doctrines of revelation respecting the state of the dead. It cannot be supposed consistent with a just reverence of God to believe, that he has subjected the souls of the departed, not excepting those of the most eminent saints and prophets, to be remanded back from their distinct abodes, by the practice of the most execrable rites, and at the call of some of the vilest mortals, and compelled to reveal what he has seen fit to conceal. Natural reason confirms the suffrage of scripture, when it brands the whole magic art, to which evocations of the dead, and all necromantic divinations appertain, as founded in imposture. Others, who cannot admit that witches are able to disturb the souls of good men, much less of prophets, are nevertheless of opinion, that these wretched women can cause the devil to counterfeit the souls of the dead; and that in the case before us, an evil spirit appeared before Saul in the likeness of Samuel. (See Patrick on 1 Sam. xxviii. 12.) But this opinion gives an unwarrantable advantage for the support of idolatry to those impostures that were practised by heathen forcerers and diviners. Besides, the very apparition of a spiritual and incorporeal being, and the gift of prophecy, are real miracles, and cannot take place but by divine appointment: and lastly, the historian calls the appearance to Saul Samuel, which he could not do with truth, if it was no other than the devil, who here appears, not as a tempter, but as a very severe reprover of impiety and wickedness.

Many learned men have, therefore, maintained, that it was neither Samuel, nor an evil spirit, who here appeared to Saul; but that the whole was the work of human imposture. In support of this opinion it may be pleaded, that

the woman to whom Saul applied to call up Samuel was merely a ventriloquist, possessing an art very serviceable to those who counterfeited the answers of the dead. This opinion, however, like the foregoing one, contradicts the sacred historian, who not only represents the Pythoness as affirming, but himself affirms, that she saw Samuel, and that Samuel spoke to Saul: nor has he dropt the least hint that it was not the real Samuel of whom he was speaking.

Others have supposed, that the appearance of Samuel to Saul was a divine miracle: though whether the miracle consisted in raising Samuel, or in presenting an image or representation of him before Saul, it is not necessary to determine. Accordingly, the apparition must be ascribed, not to the power of enchantment, but to the immediate appointment of God, as a rebuke and punishment to Saul. This opinion is maintained by Dr. Waterland, in his *Sermons*, vol. ii. p. 267, and defended by Dr. Delany in his *Life of David*; but combated by Dr. Chandler, with objections which, as far as they affect the scripture history of the matter, are answered or obviated by Mr. Farmer, in his *Dissertation on Miracles*, p. 486, &c.

WITCH-HAZLE, in *Botany*. See HAZLE.

WITCH ISLAND, in *Geography*, one of the smaller Virgin islands; 6 miles E. of St. John.

WITCHCRAFT, the crime of forcery, especially in women.

Many think there may be some foundation for what we call fascination and witchcraft. We have innumerable instances and histories to this purpose; which it would not be fair to set aside, merely because they are not reconcilable to our philosophy: but, as it happens, there seems to be something in philosophy to countenance some of them.

Indeed, the ridiculous stories that are generally told, and the many impostures and delusions that have been discovered, in all ages, are sufficient to demolish all faith in such a dubious crime; if the contrary evidence were not also extremely strong. Wherefore, (says judge Blackstone,) it seems to be the most eligible way to conclude, with an ingenious writer of our own (*Spect.* N^o 117.), that in general there has been such a thing as witchcraft, though one cannot give credit to any particular modern instance of it. Some readers will, however, probably dissent from this inference of Mr. Addison, and the opinion of the learned judge, and incline to consider witchcraft in general as a species of imposture. See MAGICIAN, and MIRACLE.

What the writers in favour of the opinion advance, as their reasons, is as follows:

All living things, they say, emit effluvia, both by the breath and the pores of the skin. All bodies, therefore, within the sphere of their perspiratory or expiratory effluvia, will be affected by them; and that, in this or another manner, according to the quality of the effluvia; and in this or that degree, according to the disposition of the emittent and recipient parts.

This, indeed, is incontestible; nor need we produce instances of animals exhaling sweet or stinking smells; or of infectious diseases conveyed by effluvia, &c. in confirmation of it.

Now, of all parts of an animal body, the eye, we know, is the quickest. It moves with the greatest celerity, and in all the variety of directions. Again, its coat and humours are permeable as any other part of the body (witness the rays of light it so copiously receives.) The eye, therefore, no doubt, emits its effluvia like the other parts. The fine humours of the eye must be continually exhaling. The heat of the pervading rays will rarefy and attenuate them: and that, with the subtle juice or spirit of the neighbour-

ing optic nerve; supplied in great abundance by the vicinity of the brain, must make a fund of volatile matter to be dispensed, and, as it were, determined by the eye.

Here, then, we have both the dart, and the hand to fling it. The one furnished with all the force and vehemence, and the other with all the sharpness and activity, one would require. No wonder if their effects be great!

Do but conceive the eye as a sling, capable of the swiftest and intensest motions and vibrations: and again, as communicating with a source of such matter, as the nervous juice elaborated in the brain; a matter so subtle and penetrating, that it is supposed to fly instantaneously through the solid capillaments of the nerves; and so active and forcible, that it distends and convulses the muscles, and distorts the limbs, and alters the whole habitude of the body, giving motion and action to a mass of inert, inactive matter. A projectile of such a nature, flung by such an engine as the eye, must have an effect wherever it strikes: and the effect will be limited and modified by the circumstances of the distance, the impetus of the eye, the quality, subtilty, acrimony, &c. of the juices, and the delicacy, coarseness, &c. of the object it falls on.

This theory, it is supposed by many, may account for some of the phenomena of witchcraft, particularly of that branch called fascination. It is certain the eye has always been esteemed the chief seat, or rather organ, of witchcraft; though, by most, without knowing why, or wherefore: the effect was apparently owing to the eye; but how, was not dreamed of. Thus, the phrase, to have an *evil eye*, imports as much as to be a witch. And hence Virgil,

“Nescio quis teneros oculus mihi fascinat agnos.”

Again, old bilious persons are those most frequently supposed to have the faculty; the nervous juice in them being depraved and irritated by a vicious habitude of body, and so rendered more penetrating and malignant. And young persons, chiefly children and girls, are most affected by it; because their pores are patent, their juices incoherent, and their fibres delicate and susceptible. Accordingly the witchcraft mentioned by Virgil only reaches to the tender lambs.

Lastly, the faculty is only exercised when the person is displeased, provoked, irritated, &c. it requiring some extraordinary stress and emotion of mind to dart a proper quantity of the effluvia, with a sufficient impetus, to produce the effect at a distance. That the eye has some very considerable powers is past dispute.

The ancient naturalists assure us, that the basilisk and ophlepa kill other animals merely by staring at them. If this fail of credit, a late author assures us to have seen a mouse running round a large snake, which stood looking earnestly at it, with its mouth open; still the mouse made less and less circles about it; crying all the while, as if compelled to it; and, at last, with much seeming reluctance, ran into the gaping mouth, and was immediately swallowed.

Who has not observed a setting-dog; and the effects of its eye on the partridge? The poor bird, when once its eyes meet those of the dog, stands as if confounded, regardless of itself, and easily lets the net be drawn over it. We remember to have read of squirrels also stupified and overcome by a dog's staring hard at them, and thus made to drop out of the trees into his mouth.

That man is not secure from the like affections is matter of easy observation. Few people but have, again and again, felt the effects of an angry, a fierce, a commanding, a dis-

dainful, a lascivious, an intreating eye, &c. These effects of the eye, at least, make a kind of witchcraft. But our readers will excuse our enlarging.

Witchcraft prevailed to such a degree both in England and Scotland in the 16th century, that it attracted the attention of government under the reign of Henry VIII., in whose 33d year was enacted a statute which adjudged all witchcraft and forcery to be felony without benefit of clergy; and at the commencement of the reign of Elizabeth, the evil seems to have been very much on the increase; for bishop Jewel, in a sermon preached before the queen in 1558, tells her; “It may please your grace to understand that witches and forcerers within these four last years are marvellously increased within your grace's realm. Your grace's subjects pine away even unto the death, their colour fadeth, their flesh rotteth, their speech is benumbed, their senses are bereft; I pray God they never practise further than upon the subject.” Of the prevalence of this delusion in 1584, we have the testimony of Reginald Scot, in his treatise intitled “The Discoverie of Witchcraft,” written in behalf of the poor, the aged, and the simple, as the author informs us; and it reflects singular discredit on the age in which it was produced, that a detection so complete, both with regard to argument and fact, should have failed in effecting its purpose. The mischief, instead of being restrained, was rapidly accelerated by the publication of the “Dæmonologie” of king James, at Edinburgh, in the year 1597; and the contagion was promoted by the succession of James to the throne of Elizabeth. In the year 1603, the royal treatise was printed at London, with an alarming preface concerning the increase of witches or enchanters, “these detestable slaves of the devil;” and it was accompanied by a new statute against witches, which describes the crime in a variety of particulars, and enacts, that offenders, duly and lawfully convicted and attainted, shall suffer death. Reginald Scot, in the treatise above-mentioned, has portrayed at large the character of those who were branded with the appellation of witches, stating the deeds that were imputed to them, and the nature of their supposed compact with the devil. The abode of a witch is admirably described by Spenser, the description being formed from an existing subject:

“There in a gloomy hollow glen she found
A little cottage built of sticks and reedes
In homely wise, and wald with fods around;
In which a witch did dwell, in loathly weedes
And wilful want, all careles of her needes:
So choosing solitarie to abide
Far from all neighbours, that her devilish deedes
And hellish arts from people she might hide,
And hurt far off unknowne whom ever she envie.”
Faerie Queene.

Scot has, with singular industry, collected from every writer on the subject the minutiz of witchcraft, and he has annexed comments for the purpose of refuting and exposing them; whereas James, the royal pedant, wrote in defence of this folly, and, unfortunately for truth and humanity, the doctrine of the monarch was preferred to that of the sage.

The old laws made in England and Scotland against conjuration and witchcraft are repealed by a late statute, and no person is to be prosecuted for any such crime. 9 Geo. II. c. 5. See CONJURATION.

WITCHES-BUTTER, a name given by the common people of England to a sort of tremella growing on the bark of old trees, in form of a corrugated membrane.

WITELSHOFEN, in *Geography*, a town of Germany,

many, in the margravate of Anspach; 7 miles S.E. of Creilshcim.

WITGENAU, or WITCHENAU, a town of Lusatia, on the Elster; 13 miles N.N.W. of Budissen. N. lat. $51^{\circ} 20'$. E. long. $14^{\circ} 16'$.

WITGENAU, or *Wittengau*, or *Trsebon*, a town of Bohemia, in the circle of Bechin, on the river Launicz; 22 miles S.S.E. of Bechin. N. lat. $49^{\circ} 4'$. E. long. $14^{\circ} 40'$.

WITGENSTEIN, a county of Germany, situated between the principalities of Hesse Darmstadt, Nassau Dillenburgh, and the duchy of Westphalia; about 18 miles long, and 12 broad. Some parts are mountainous and woody, and contain mines of silver, copper, and iron; the pastures are good, but the arable land inconsiderable. The principal rivers are the Lahn and the Eder. It is united to the county of Sayn, and that princely house is divided into two branches, Sayn Witgenstein of Witgenstein, and Sayn Witgenstein of Berleburg, each of which had a distinct vote in the Imperial college, and in the diet of the Upper Rhine. The county takes its name from a feat, the residence of the counts, which is situated on a mountain; 1 mile N. of Laafphe.

WITGEWALT, a town of Prussia, in Oberland; 8 miles N.E. of Osterrode.

WITH-VINE, or WINE, in *Agriculture*, a term provincially signifying couch, or couch-grass. See *BIND-Weed*.

WITHAM, in *Geography*, a market-town and parish in the hundred of the same name, in the county of Essex, England, situated on a branch of the river Blackwater, $8\frac{3}{4}$ miles N.E. from Chelmsford, and $37\frac{3}{4}$ in the same direction from London. By the parliamentary returns of 1811, the number of houses in the parish was 466, and the inhabitants amounted to 2352. Witham has a weekly market on Tuesday, and fairs on Friday and Saturday of Whit-week, on the 14th of September, and 8th of November. The petty sessions for the Witham division of the county are also held in the town. Witham is supposed to have been constituted a town by Edward the Elder, though perhaps it was only restored by him, at least the part on Cheping Hill round the church, which stands about half a mile N.W. from the other part of the town. On this eminence are considerable remains of a circular camp, inclosed by a double ditch and rampart. From this work, and the quantity of Roman bricks worked up in the body and tower of the church, Witham has been thought to occupy the position of the Canonium of Antoninus. The manor was anciently possessed by earl Harold, and afterwards by Eustace, earl of Boulogne, who married the sister of Edward the Confessor. Near the east end of the town is a mansion, now possessed by Thomas Kynaston, esq., but formerly belonging to the late earl of Abereorn. Faulkbourne-hall, between one and two miles N.W. from Witham church, is the seat of colonel Bullock, formerly member of parliament for the county of Essex. Here is a cedar-tree, about nineteen feet in circumference near the ground. A coin of Domitian and vestiges of walls indicate the Romans to have had a villa at this place.—*Beauties of England and Wales, Essex*. By J. Britton and E.W. Brayley, 8vo. 1808.

WITHAM, a river of England, in the county of Lincoln, which rises in the south part of Lincolnshire, on the borders of Leicestershire, passes by Grantham to Lincoln, where it becomes navigable; from thence it passes by Tatterfall, Boston, &c. and runs into the German sea, 5 miles below Boston, in what are called the *Wasbes*.

WITHE, in *Agriculture*, a small twisted stick of any kind used as a band.

WITHER-BAND, in *Rural Economy*, the band or piece of iron which is laid underneath a saddle, about four fingers above the withers of the horse, to keep tight the two pieces of wood that form the bow of the saddle.

WITHER-WRUNG, in the *Manege*. A horse is said to be wither-wrung, when he has got a hurt in the withers; which sort of hurts it is very hard to cure. See *WITHERS*.

WITHERING, WILLIAM, M.D. F.R.S., in *Biography*, was born in 1741, and finished his medical education in the university of Edinburgh, where he took his degree of doctor in 1766. From Stafford, where he first settled and married, he removed to Birmingham, and speedily attained by his skill and assiduity to very extensive and profitable practice; without seeking much society or neglecting his scientific pursuits in order to secure it. The chief objects of his attention, independently of his professional engagements, were botany and chemistry. The result of his scientific inquiries and labours appears in the following list of his valuable publications; viz. "A Botanical Arrangement of British Plants," in 2 vols. 8vo. 1776, which passed through two more editions, in 1787, 3 vols., and in 1796, 4 vols., with numerous improvements and additions, some of which were suggested by his friends, and particularly by Dr. Stokes. In chemistry and mineralogy, a translation of Bergman's "Sciagraphia Regni Mineralis," 1783, and the following papers in the *Philosophical Transactions*; "Experiments on different Kinds of Marle found in Staffordshire," 1773; an "Analysis of the Toad-stone of Derbyshire," 1782; "Experiments on the Terra Ponderosa," 1784; and "Analysis of a Hot Mineral Spring in Portugal," 1798. In the improvement of his own profession, "Account of the Scarlet Fever and Sore Throat, particularly as it appeared at Birmingham in the year 1778;" and "An Account of the Fox-glove and some of its Medical Uses; with Practical Remarks on the Dropsy and other Diseases," 1785. Subject to pulmonic attacks, which weakened his lungs, he thought it necessary, in 1793 and 1794, to pass the winter in a warmer climate, and he fixed on Lisbon. Afterwards he became incapable of his former professional exertions, and died at the Larches, near Birmingham, in November 1799, at the age of 58. In his intellectual character he joined unremitting application with sagacity and discernment. In his medical practice he limited prescription to that quantity and kind of medicine which was absolutely necessary for his patients; and if any in the inferior branches of the profession disliked this mode of practice, their disapprobation of it was a testimony in its favour. In his disposition he was mild and humane; and his natural reserve did not preclude him from the pleasure of rational society. His valuable library and handsome property were inherited by an only son. *Gen. Biog.*

WITHERING, in *Medicine*. See *ARIDURA*.

WITHERING of a Cow, is when, after calving, she does not cast her cleanting, which, if not timely remedied, will kill her.

WITHERINGIA, in *Botany*, was so named by the great French botanist, M. L'HERITIER, (see that article,) in compliment to the late Dr. William Withering, F.R.S. F.L.S., the well-known author of a most useful and popular English work, entitled an "Arrangement of British Plants," which has gone through several editions, in some of the earlier of which Dr. Stokes was his coadjutor. (See *STOKESIA*.) —L'Herit. Sert. Angl. 33. Schreb. Gen. 791. Willd. Sp.

Sp. Pl. v. 1. 622. Mart. Mill. Dict. v. 4. Ait. Hort. Kew. v. 1. 248. ed. 1. v. 1. 149. Juss. 450. Lamarck Illustr. t. 82.—Clafs and order, *Tetrandria Monogynia*. Nat. Ord. *Lurida*, Linn. *Solanca*, Juss.

Gen. Ch. *Cal.* Perianth inferior, of one leaf, very short, obfcurely four-toothed, permanent. *Cor.* of one petal, wheel-shaped: tube very short, nearly globular: limb in four deep, lanceolate, acute, recurved fegments. Nectary four fightly-bordered cavities, in the tube of the petal. *Stam.* Filaments four, erect, roundifh, downy, inferted into the bafe of the corolla; anthers converging, ovate, two-lobed, burfting at the fides. *Pift.* Germen fuperior, ovate; ftyle thread-shaped, rather longer than the ftamens; ftigma capitate. *Peric.* Berry roundifh, of two cells. *Seeds* numerous, inferted into the divided receptacle.

Eff. Ch. Corolla deeply four-cleft, reflexed; its tube with four external prominences, internally concave. Calyx obfcurely four-toothed. Anthers converging, burfting laterally. Berry with two cells, and many feeds.

1. *W. folanacea*. Yellow-flowered Witheringia. Willd. n. 1. Ait. n. 1. L'Herit. Sert. Angl. 33. t. 1.—Native of South America. A ftove plant, flowering moft part of the year, and cultivated as early as the year 1742 by the celebrated lord Petre. Its appearance and characters, fo nearly approaching to *Solanum*, had caufed this plant to be neglected by botanifts, till the eager and piercing eyes of M. L'Heritier detected its differences, and eftablifhed its generic characters. The mode of burfting of the *anthers* more efpecially ftamp the genus as diftinct from *Solanum*. The *root* is perennial. *Stem* herbaceous, hardly a foot high, round, downy, reddifh, rendered flightly angular by the decurrent *footftalks*. *Leaves* in alternate pairs, ftalked, ovate-oblong, acute, wavy, entire, rather downy, four or five inches long. *Flowers* about the fize and fhape of *Solanum nigrum*, except being only four-cleft, pale yellow, drooping, in many-flowered, axillary, feffile *umbels*; their *ftalks* round, fmoth, half an inch, or more, in length. *Stamens* whitifh, internally hairy. Few exotics are lefs likely to be cultivated for ornament, however interefting for the fake of its name and characters to a fcientific botanift.

WITHERITE, in *Mineralogy*, a name given to the carbonate of barytes, in honour of Dr. Withering, by whom this mineral was frft difcovered, as containing an earth before unknown. (See BARYTES.) Witherite occurs generally mafive, and fometimes cryftallized, in fix-fided prifms terminated by fix-fided pyramids, in which the edges and points are often truncated. It occurs alfo in double fix-fided pyramids. When mafive, it is often found in globular concretions, which have a radiated diverging ftructure. The principal fracture has a fhining luftre; the crofs fracture is glimmering. It is tranflucent, and is moft generally of a yellowifh-white colour, but is fometimes of a pale blueifh-grey, or flefth-red. Witherite is eafily frangible; it breaks into wedge-shaped fragments; it yields eafily to the knife.

The fpecific gravity is 4.3; it decrepitates flightly before the blow-pipe, and melts very readily into a white enamel. It is foluble with effervescence in dilute muriatic or nitric acid. It contains,

Barytes	-	-	-	-	-	79.66
Carbonic acid	-	-	-	-	-	20.
Water	-	-	-	-	-	.33

Witherite was frft difcovered at Anglefark, in Lancafhire, in a vein of lead-ore, accompanied with heavy fpar.

It occurs in confiderable quantities on the weftern fide of Yorkfhire, and in the counties of Northumberland, Durham, and Weftmoreland, in veins which traverse mountain lime-ftone and fand-ftone. In fome of thefe veins it has been obferved, that when the vein paffes through the lime-ftone, it contains Witherite, or carbonate of barytes; but where it paffes through the fand-ftone, it contains fulphate of barytes, or heavy fpar. It fometimes occurs in a ftatuecal or cellular form, and diffeminated in other minerals.

Witherite is rather a fcarce mineral on the continent. It is a very active poifon. It has not been ufed in the arts in this country. It is probable that it may be employed on the continent in the decomposition of the alkaline fulphates, as foreigners fometimes obtain it from the mines in Yorkfhire in confiderable quantities.

WITHERNAM, in *Law*, a reprifal, or taking of other goods or cattle, in lieu of thofe unjuftly taken and effoined, or otherwife withholden.

The word is compounded of the Saxon *wither*, *contra*, *againft*; and *nam*, *captio*, *taking*. See NAAM.

Where goods are taken by colour of diftreff, and driven to a hold, or out of the county, fo that the fheriff cannot, upon replevy, make deliverance thereof to the party diftrained; in this cafe, the writ of *capias in withernam*, or *de vetito namio*, is iffued, directed to the fheriff, for the taking as many of the party's beafts, as he did thus unlawfully diftrain; or as much goods of his, till he has made deliverance of the frft diftreff: and, therefore, goods taken in withernam cannot be replevied, till the original diftreff is forthcoming.

WITHERNAM, *Homine capto in*. See HOMINE.
WITHERS of a *Horfè*, the juncture of the foulder-bones at the bottom of the neck and mane, towards the upper part of the foulder.

Thefe parts fhould be well raifed and pretty ftrong, for this is a fign of ftrength and goodnefs in the horfe. They keep the faddle from coming forward upon the horfe's fhoulders and neck, which immediately galls and fpoils him. A hurt in this part is very difficult to cure, and, for this reafon, they fhould be lean rather than flefthy, as they are then lefs fubject to be bruifed and hurt by the faddle.

When there are fores on the withers, the caufe muft be looked to, in order to determine a proper cure, and prevent a return. If the hurt be caufed by the largenefs of the faddle-bands, provided that it be not too great, it may be eafily cured by the following remedy: take the whites of fix eggs, beat them with a piece of alum as big as an egg for a quarter of an hour, or till the whole is reduced to a thick fcum or froth; let the fwelling be rubbed well with this mixture, and then covered over with more of the froth; this is to be left to dry on, and the application is to be repeated every ten or twelve hours; notwithstanding that the heat and fwelling remains, this, by degrees, will take place, though not at frft.

If the hurt be great, recourfe muft be had to bleeding; and this may be repeated after two days, if the fwelling and inflammation continue.

If a tumour, with great inflammation, follow a bruife with the faddle-bows, the part affected is to be rubbed with lime-water, and covered with a lamb's skin, the woolly part next the back; after the washing, the ointment, well known among our farriers by the name of the *duke's ointment*, is to be applied; and if the tumour inclines to fuppurate, the ointment muft be wafhed off with a mixture of vinegar and water, warmed, mixed with a handful of falt to every quart of it: an ointment is then to be made of half a pound of populeon, and a quarter of a pound of black foap, and as much

much honey: these are to be thinned with a large glass of spirit of wine, and the part is to be well rubbed with some of this three or four times a-day, covering it afterwards with a lamb's skin. Some use instead of this ointment a poultice made of powder of cummin-seed, linseed-oil, and pigeons' dung, which does as well.

Where these means are not sufficient to remove such tumours or swellings, a more effectual remedy may frequently be found in the blistering liniment.

But wherever matter is formed and distinctly felt by the finger, an opening should be made as near as possible to the most depending part of it, to allow of a free discharge of it, and a rowel be introduced through the whole extent of the cavity, and be frequently moved, and washed with spirits of turpentine; the healing process being promoted by the injection of stimulating washes.

In cases where sinuses are formed, and these means are insufficient for healing the parts, the cure must be performed by making an incision through the whole extent of the hollow parts; dressing them afterwards in such a manner as to keep down the proud flesh, and preserving the wounds clean, as well as aiding the growth of new flesh by proper means. See *ULCER*, and *WOUND*, in *Animals*.

WITHERS of the Bow of a Saddle, in the *Manege*. See *Bow*.

WITHTY, a large species of willow, fit to be planted upon high banks and sides of ditches, within reach of the water, or on the weeping sides of hills.

WITHTY-Cragged, a term sometimes applied to a disease in horses. See *STRAIN*.

WITLAGE, in *Geography*, a town of Westphalia, in the bishopric of Osnabruck; 11 miles E.N.E. of Vorden.

WITLAH, a town of Germany, in the county of Verden; 3 miles S.E. of Verden.

WITLOWIZ, a town of Bohemia, in the circle of Koniggratz; 16 miles N.N.E. of Gitschin.

WITMARSEN, a town of Germany, in the bishopric of Munster; 7 miles W. of Lingen.

WITNESS, TESTIS, a person who certifies or asserts the truth of any fact.

All witnesses are deemed *competent*, who, having the use of their reason, are neither infamous nor interested in the event. See *EVIDENCE*.

Among the Romans, it was a custom to pull or pinch the ears of witnesses present at any transaction; that they might remember it when they were called to give in their testimony. Two eye-witnesses, or *de visu*, not suspected, are to be deemed a conclusive proof.

False witnesses, suborners of witnesses, &c. in England are punished with the pillory; in several other countries, with death. See *PERJURY*, *SUBORNATION*, &c.

In a synod at Rome, under Constantine, in the year 320, it was decreed, that there should be seventy-two witnesses heard, to condemn a bishop; which was called *libra testium*, a pound of witnesses. Accordingly there were seventy-two witnesses heard against pope Marcellinus; who, says the historian, *erant electi libra occidua*.

Anciently there were synodal witnesses, *testes synodales*, in each parish, chosen by the bishop, to inquire into the heresies, and other crimes, of the parishioners; and to make oath thereof on the relics of the saints. See *SYNODALES*.

WITNESS, Attic. See *ATTIC*.

WITNESSES, Trial by, in *Law*, is a species of trial, without the intervention of a jury. This is the only method of trial known to the civil law; in which the judge is left to form in his own breast his sentence upon the credit of the witnesses examined: but it is very rarely used in our law,

except only that when a widow brings a writ of dower, and the tenant pleads that the husband is not dead; this is, in favour of the widow and for greater expedition, allowed to be tried by witnesses examined before the judges; and also in some other cases mentioned by sir Edward Coke, as, to try whether the tenant in a real action was duly summoned, or the validity of a challenge to a juror: who observes, that in every case the affirmative must be proved by two witnesses at the least. Blackst. Com. book iii.

WITNEY, in *Geography*, in the hundred of Bampton, and county of Oxford, England, is a long and irregular, but large and populous market-town, situated 11 miles W.N.W. from Oxford, and nearly 66 in the same direction from London. Through the town runs the little river Windrush. Witney was one of the eight manors given to his cathedral in 1040 by Alwin, bishop of Winchester, in consequence of the suspicion of his improper conduct with Emma, the mother of Edward the Confessor. The queen-mother cleared herself by the fiery ordeal (an experiment of probably little danger), and the bishop made reparation for the scandal he had, although innocent, brought upon his church by a transfer to the clergy belonging to it of eight of his manors. In 1171 the manor was, by bishop Blois, bestowed on his new foundation of St. Cross, near Winchester. In the fifth year of Edward II. Witney became a borough, and continued to send members to parliament till the 33d year of Edward III. when the privilege was declined: it is still, however, called a borough, and governed by two bailiffs. The church, terminating the principal street, is large and handsome, with cross aisles, surmounted by a tower and spire. A free-school was founded here in 1660, and other charitable institutions for the education of youth have lately been formed. Witney has long been celebrated for the manufacture of blankets, of which the weavers were incorporated in queen Anne's reign. When Dr. Plott published his Natural History of Oxfordshire, in 1677, the weaving business employed no fewer than 3000 persons, "from children of eight years old, to decrepit old age;" a number probably not exaggerated, if it be considered, that, in his time, every part of the manufacture was performed by manual labour. But in the latter half of the last century the blanket trade suffered a great defalcation. In 1768 about 500 weavers only were employed, a number which gradually sunk to less than one half: the consequence of which was great distress among the inhabitants. Machinery was introduced into the manufacture, by which one man performed the work of two. The blanket business again revived; but the working hands reaped no benefit from its revival. In 1807, when the price of blankets was five pounds the pair, the workmen earned but twelve shillings per week, the same sum as in 1768, when the pair brought only three pounds. The staple, or blanket-hall, stands in the high street, as does also the town-hall, under which is a place for the market. The rectory of the parish is united with the vicarage, and in the patronage of the bishop of Winchester. The town contains meeting-houses for different descriptions of dissenters. According to the population return of 1811, the houses in the town were 543, and the inhabitants 2722.—Plott's Natural History of Oxfordshire, 1677 and 1705, fol. Beauties of England, Oxfordshire, by J. N. Brewer, 8vo. 1813.

WITRY, a town of France, in the department of the Marne; 6 miles N.E. of Reims.

WITSENIA, in *Botany*, was so named by professor Thunberg, in compliment to Mr. Witsen, "Counsellor to the Chief Magistrate of Amsterdam," whom he styles a most eminent patron and promoter of every kind of science.

Professor

Professor Martyn supposed the honour had been designed for Nicholas Witsen, a writer on shells, who gave one of the earliest accounts of New Holland. (See Phil. Trans. v. 17 and 20.) Thunberg's mission to Japan appears to have been furthered by the influence of the above-named gentleman. We can only rely on him for the propriety of the appellation in question.—Thunb. Nov. Gen. 33. Murray in Linn. Syst. Veg. ed. 14. 83. Schreb. Gen. 37. Willd. Sp. Pl. v. 1. 247. Vahl Enum. v. 2. 47. Mart. Mill. Dict. v. 4. Ker in Sims and Kon. Ann. of Bot. v. 1. 236. Ait. Hort. Kew. v. 1. 109. Juss. 59. Lamarck Illustr. t. 30.—Class and order, *Triandria Monogynia*. Nat. Ord. *Enfatae*, Linn. Ker. *Irides*, Juss.

Gen. Ch. *Cal.* none, unless the upper pair of the *bracteas* be so considered. *Cor.* of one petal, tubular, erect: tube cylindrical, slender at the base, gradually dilated at the top: limb spreading, regular, in six deep, equal, obovate segments. *Stam.* Filaments three, very short, inserted into the mouth of the tube, at the base of three alternate segments of the limb; anthers oblong, erect. *Pist.* Germen superior, roundish, small: style thread-shaped, erect, longer than the tube of the corolla, slightly curved at the extremity; stigma in three short, equal, rather spreading segments. *Peric.* Capsule membranous, of three cells and three valves. *Seeds* several, angular.

Eff. Ch. Calyx none. Corolla with a cylindrical tube; limb in six deep, equal, obtuse segments. Stigma slightly three-cleft. Capsule of three cells, with several angular seeds.

1. *W. maura*. Downy-flowered Witsenia. Thunb. Nov. Gen. 34. t. 2. f. 1. Fl. Cap. v. 1. 255. Willd. n. 1. Vahl n. 1. Ait. n. 1. Redout. Liliac. t. 245. (*Antholyza maura*; Linn. Mant. 175.)—Flowers terminal, in pairs. Outer segments of the corolla externally downy.—Native of the shady sides of hills, at the Cape of Good Hope, flowering in April and May. Sent to Kew by Mr. Masson, in 1790, but it does not appear to have blossomed in that collection, nor elsewhere in Europe, M. Redoute's fine figure being made from a dried specimen, aided by description. The root is perennial and woody. *Stem* shrubby, erect, more or less branched, two feet high, compressed; naked in the lower part, and appearing as if jointed, from the scars left by former foliage; leafy above. *Leaves* numerous, alternate, sessile, two-ranked, equitant, four or five inches long, compressed, striated, acute, entire. *Flowers* in pairs at the extremities of the short terminal branches, crowded, more or less numerous, into a corymbose tuft. *Corolla* two inches long: its tube yellow at the base, dark blue for a considerable extent in the upper part; limb yellow, scarcely spreading, full half an inch long, clothed externally with dense shaggy pubescence of a very peculiar kind, confined to the tips of the inner segments.

2. *W. corymbosa*. Corymbose Witsenia. Ker in Curt. Mag. t. 895. Ait. n. 2. Sm. Exot. Bot. v. 2. 17. t. 68.—Corymb many-flowered. Corolla externally smooth.—Native of the Cape of Good Hope. Raised from seed by G. Hibbert, esq. in 1803. A green-house plant, flowering in spring and autumn. The stem is shrubby, from four to six inches high. *Leaves* like the last, but only half the size, somewhat glaucous. *Flowers* very numerous, bright blue, in a forked corymbose, compound panicle, supported by a long stalk, at first terminal, but soon becoming lateral. *Bracteas* two pair at the base of each flower, concave, obtuse. *Corolla* about an inch long, including its horizontal limb.

3. *W. ramosa*. Branching Witsenia. Thunb. Fl. Cap. v. 1. 256. Vahl n. 2. (*W. fruticosa*; Ker in Ann. of

Bot. v. 1. 237. *Ixia fruticosa*; Thunb. Diff. n. 1. t. 1. f. 3. Lamarck Illustrat. t. 31. f. 4. Linn. Suppl. 93.)—Stem much branched. Corolla externally smooth; its tube capillary, twice the length of the limb.—Native of hills at the Cape of Good Hope, flowering in October, November, and December. The stem is a span high at most, remarkably woody, repeatedly branched in a corymbose manner; naked below; the branches compressed, two-edged, knotty or scarred as if jointed, leafy at their extremities. *Leaves* equitant, two-ranked, linear, narrow, one and a half or two inches long, rather glaucous; reddish at the base. *Flowers* terminal, very few together, if not quite solitary, blue, remarkable for the length and slenderness of their tube, which sometimes measures nearly two inches; the limb is rather less spreading, and more bell-shaped, than that of *corymbosa*. *Bracteas* membranous, elongated, brownish.

4. *W. pumila*. Dwarf Witsenia. Vahl n. 3. (*Ixia pumila*; Forst. Comm. Gott. v. 9. 20. t. 2. *I. magellanica*; Lamarck Illustr. v. 1. 109. *Moræa magellanica*; Willd. Sp. Pl. v. 1. 241, excluding Cavanilles' synonym. *Tapeinia*, Juss. 59.)—Stems simple, single-flowered.—Gathered by Forster, Commerçon, and others, at the straits of Magellan. The root is perennial, long, branched, bearing dense tufts of numerous, simple, leafy stems, an inch or inch and a half high. *Leaves* crowded, two-ranked, awl-shaped, compressed, strongly ribbed, about an inch long. *Flowers* whitish, small, solitary, nearly sessile, among the uppermost leaves, which form a kind of sheath, but each appears to have also a bivalve sheath, or pair of bracteas, which are permanent. Capsule brown, with rather rigid, emarginate valves.

Mr. Ker observes, that this is the only genus of its natural order whose habit is in any degree shrubby. He mentions, in the Annals of Botany, another species, by the name of *partita*, seen by himself in Mr. Hibbert's herbarium; but without any indication of its characters, so that we have no means of knowing how it differs from the foregoing.

WITSIO, in *Geography*, a town of Sweden, in the province of Schonen; 28 miles N.N.W. of Christianstad.

WITT, JOHN DE, in *Biography*, the son of a burgo-master of Dordrecht, was born in 1625, and educated in various useful sciences, so as to excel in a knowledge of jurisprudence, politics, and mathematics, in the latter of which he was so great a proficient, that he wrote a treatise on the elements of curve-lines, which was published under the inspection of Francis Schooten. For further improvement he spent some years in travel, and upon his return was elected to his father's post of pensionary of Dordrecht. Attached by his descent to the principles of republicanism, and jealous of the house of Orange, he opposed the elevation of this house, and dissuaded the province of Zealand from conferring the office of captain-general upon the young prince, William III. His conduct in this business was much approved, and he was henceforth regarded as at the head of the political administration of the United Provinces. This was a period peculiarly critical and interesting. The war with the new English republic distressed the states; it was injurious to their trade and finances; and presented to the Orange party a favourable opportunity for advancing prince William to the power and dignities possessed by his ancestors. Peace at length became absolutely necessary; and one of the articles concluded upon in 1654, and dictated by Cromwell, was the perpetual exclusion of the prince of Orange from the high offices formerly held by his family. This article was agreed to by the states of Holland alone, and when De Witt drew up a declaration for divulging it,

it, some of the provinces censured it, and charged the anti-Orange party with having suggested it to Cromwell. The province of Holland, however, carried the point, and the general tranquillity was little disturbed. De Witt now directed his attention to the state of the finances, and succeeded in reducing the interest of the public debt, and persuading the people to acquiesce in this measure. The restoration of Charles II. was generally agreeable to the United States, and more especially to the Orange party: but the restored sovereign soon declared his dissatisfaction with De Witt, because he had been hostile to the elevation of the house of Orange. From this time, the Dutch statesman favoured the politics of France more than those of England. At length a war took place between the Dutch and English in 1665; during the progress of which De Witt was often unpopular, though he was the main spring which kept in action the resources of the state, and remedied every calamity. Peace with England in 1667 developed the ambitious projects of Lewis XIV. in taking possession of the Spanish Netherlands; and the alarm which this measure produced in the United Provinces gave occasion to the friends of the house of Orange to propose the elevation of the young prince to the dignities which his family had possessed. De Witt, with a view of counteracting this purpose, obtained a resolution on the part of the states of Holland for separating the offices of captain-general and stadtholder (see WILLIAM III.), which resolution gave great offence to the other provinces, and rendered De Witt, with whom it was supposed to have originated, extremely unpopular. Sensible, however, of the dangers arising from French ambition, he concurred in the triple alliance between England, Sweden, and the United Provinces, concluded, in 1668, by himself and sir William Temple. The states of Holland were so satisfied with his conduct, that they nominated him for five years more to the office of their pensionary, which he had already occupied for fifteen years. Confiding in the triple alliance, and the subsequent peace of Aix-la-Chapelle, he again indulged his jealousy of the Orange party and a standing army, and considered the danger from France as a secondary object. But the ambition of Lewis had no bounds; the unprincipled Charles II. could not be relied upon; the triple alliance was set aside; and the English cabinet joined the French in direct war with the United Provinces; so that in the year 1672 a French army made an irruption into the territories of the states, and threatened to overwhelm the whole country. The anti-Orangists were then compelled to confer the chief command on William. The conduct of the French had been so atrocious, that every person who had manifested the slightest attachment to their politics was charged with treason. De Witt became the object of public indignation, and to him were ascribed all the calamities which were felt or feared. Four assassins attempted his life, as he was returning home from an assembly of the states of Holland, attended by a single servant; but though he received many wounds, none of them were mortal. One of the assassins was taken and executed; but such is the influence of party, the friends of the house of Orange regarded the wretch as a martyr. Cornelius de Witt, on his return from the fleet, where he had served as deputy of the states, narrowly escaped from a similar attempt. The prince was now elevated to the stadtholderate; and the pensionary, as soon as he was recovered from his wounds, visited him with congratulation on the event, but was coolly received. Finding that, as he was become an object of the public hatred, he could be no longer of any service, he requested permission from the states of Holland to resign his office, which was granted him upon the most honourable terms. His brother was at this time imprisoned among common

felons at the Hague, under a charge, preferred by a person of infamous character, of having formed a plot against the life of the prince of Orange. On his trial he was put to the torture, in the most cruel form of applying it; but though he endured the most aggravated sufferings, protesting his innocence, and citing his judges before the tribunal of God for their treatment of him, they pronounced sentence, which deprived him of all his dignities, and banished him for life from the province. Although no criminal charge was brought against John de Witt, the enemies of the family resolved that neither of the brothers should escape with life. Deceyed by a fictitious message to visit his brother Cornelius in the prison, a furious mob assembled to prevent his return. The states of Holland ordered a guard to disperse the people, and requested some companies of horse and foot to be sent from the camp of the prince of Orange. But the commanding officers were inveterate in their enmity against the De Witts; and the inflamed populace, not restrained from executing their bloody purpose, forced open the doors of the prison, dragged out the two brothers, and inhumanly massacred them. This catastrophe took place in August 1672, John de Witt being in the 47th year of his age. Although the states of Holland pronounced the deed to be detestable, and requested the stadtholder to take proper measures for avenging the death of these two brothers, it was pretended that it would be dangerous to inquire into a deed in which the principal burghers of the Hague were concerned, and therefore none of the murderers were brought to justice. It should, however, be recollected, that the prince never spoke of this massacre without the greatest horror.

The character of De Witt has been described in honourable terms by sir William Temple, who knew him well, both in private life and in his public station. He speaks of him as a person of indefatigable application, of invincible resolution, of a sound and clear judgment, and of irreproachable integrity, inasmuch, that if he was blinded in any respect, it was in consequence of his passion for promoting what he thought the welfare of his country. He bears testimony to the pensionary's knowledge of the interests of foreign courts, though he did not make sufficient allowance for the treachery of princes, or rather their ministers, and was thus misled with regard to the ambitious views of France. If he had any wrong bias in his political conduct, it was that of an hereditary jealousy and dislike of the house of Orange, which led him in some cases to act rather as a party leader than an unprejudiced patriot. No man could be less influenced than De Witt by views of avarice or ostentation. His manners and appearance were adapted to the ancient simplicity and frugality of his country, even in the height of his power. When his papers and private letters were submitted to a rigorous scrutiny after his death, nothing was discovered that could impeach his integrity. When one of the commissioners was asked what they had found in De Witt's papers; "What (said he) could we have found—nothing but probity!" As a man of business, he was scrupulously attentive to order and method; and when he was once asked, How he was able to transact such a multiplicity of affairs? he replied, "By doing only one thing at a time." Mod. Un. Hill. Gen. Biog.

WITTBACH, in *Geography*, a river of Germany, which rises near Hackenburg Sayn, and after a circuitous course runs into the Rhine, about a mile below Neuwied.

WITTELM, a small island in Steinhuder lake, with a fort; 3 miles N. of Hagenburg.

WITTELOHE, a town of Germany, in the county of Verden; 10 miles S.E. of Verden.

WITTEM, a citadel of France, in the department of the Roer. It heretofore gave name to a lordship, wholly surrounded by the duchy of Limburg; 6 miles S.E. of Aix-la-Chapelle.

WITTEN, in *Commerce*, a money of account at Pernau and Stettin, &c. At Pernau a current rix-dollar is reckoned at 60 wittens, or 75 copecks; and an Albert's rix-dollar is estimated at 80 wittens, or 100 copecks; a Pernau mark is worth 3 wittens; a Lettish mark = 2 wittens; and 4 wittens = 5 copecks. At Stettin the rix-dollar was formerly divided into 36 shillings current, 72 shillings Sundish, or 144 wittens; which monies of account are now nearly discontinued.

WITTEN, in *Geography*, a town of Germany, in the county of Mark; 7 miles S.E. of Bockum.

WITTEN *See*, a lake of the duchy of Bremen; 10 miles S.E. of Bremen.

WITTENA-GEMOTE, among our *Saxon Ancestors*, a term literally signifying a council, or assembly of sages, or wise men; applied to the great council of the land, in later days called *parliament*; which see. See also GEMOTE.

In the Saxon times, this was the chief court of the kingdom, where all matters, both civil and criminal, and those relating to the revenue, were determined. In civil and criminal matters, it was a court, in the first instance only, for facts arising in the county where it sat; but it heard and determined causes from all other counties by way of appeal. To this court were summoned the earls of each county, and the lords of each leet, as also the representatives of towns, who were chosen by their burgesses. This was the legislative and supreme judicial assembly of the Anglo-Saxon nation. As highest judicial court of the kingdom, it resembled our present house of lords; and in those periods, when the peers of the realm represented territorial property rather than hereditary dignities, the comparison between the Saxon wittena-gemote, and the upper house of our modern parliament, might have been more correctly made in their legislative capacity. The German states are recorded by Tacitus to have had national councils, and the continental Saxons are also stated to have possessed them. When the Cyning was only the temporary commander of the nation for the purposes of war, whose function ceased when peace returned, the wittena-gemote must have been the supreme authority of the nation; but when the Cyning became an established and permanent dignity, whose privileges and power were perpetually increasing till he attained the majestic prerogatives and widely-diffused property which Athelstan and Edgar enjoyed, the wittena-gemote then assumed a secondary rank in the state. This council was called by different names, and it was composed of persons who were denominated witan from their presumed wisdom, and with reference to their rank and property eadigan, (the wealthy,) optimates, principes, primates, proceres, cucionatores anglia, &c. The gemotes of the witan, without doubt, varied, as our parliaments vary, in the number and quality of the persons who from time to time attended. Most of those whose names are subscribed to councils or charters, and who appear to have been the witan who constituted the gemote, have some titles after their names; but there are some gemotes which have names without any addition. It is not easy to ascertain all the qualifications which entitled persons to a seat in the wittena-gemote. There is, however, one curious passage, cited from the *Book of Ely*, in *Gale's Script.* vol. i. p. 513, which has been alleged by some writers as ascertaining that a certain amount of property was an indispensable requisite, and that acquired property would answer this purpose as

well as hereditary property. The possession stated to be necessary to constitute one of the proceres was forty hides of land. The incident to which this passage refers occurred in the reign of Edward the Confessor. It related to the brother of an abbot, who, though nobly born, could not be reckoned among the nobility of the kingdom, because he had not an estate of forty hides of land; and, therefore, he was refused by a lady, whom he sought in marriage, till his estate was increased to that magnitude by grants of land from his brother. This passage merely proves, that a certain portion, and that a very large one, of landed property *in dominio* was a necessary qualification, under the Anglo-Saxon government, to admit any person to the "rank and degree of nobility." But no argument, says lord Littelton, can be justly drawn from hence, that, in order to be qualified for a place in the Saxon great council, or wittena-gemote, it was requisite to be lord of forty hides of land. Such a notion does not agree with any accounts that are given us of that assembly in the writings or records of those times. By a passage in the preface to Ina's laws, as translated by Wilkins, it appears, that the Saxon legislature was composed of the king, *cum omnibus suis senatoribus*, which senators Littelton supposes to have been the "nobility of the kingdom," such as afterwards formed the ordinary council of lords under our kings of Norman race; et *cum senioribus sapientibus populi sui*, by whom he understands the deputies or representatives of the people, either by election or magistracy; et *cum multa etiam societate ministrorum Dei*, which words evidently denote the inferior clergy, mentioned by Eadmer as present in the parliaments of those times. It appears also, by a paragraph in Spelman's *Councils Sub. Ann.* 855, that the Saxon constitution required not only the "presence," (see *Borough*,) but the "approbation of the people," to the enacting of a law; though, by way of marking the distinction between these and the higher orders of the state, the nobility alone set their hands to the act. "Whoever," says sir John Fortescue Aland, who was very learned in the Saxon language and legal antiquities, in his preface to the book of chancellor Fortescue on the difference between an absolute and limited monarchy, "carefully and skilfully reads the Saxon laws, and the prefaces or preambles to them, will find, that the commons of England always in the Saxon times made part of that august assembly." In a passage occurring in lib. iii. f. 56. of William of Malmesbury, we have an express declaration, that by the Saxon constitution established in England, the "people," as well as the nobles, had a right to be called to the "General Assembly" upon affairs of great moment, and to join in the "edicts" made there; so that, without "their consent," the succession to the crown could not be settled. The term *Senatus* used by this historian denotes the ordinary assembly of the nobles, which he distinguishes from the "people;" but he supposes that the latter ought to be joined to the former, in order to compose the entire legislature and great council of the nation, upon extraordinary occasions. This was agreeable to the custom ascribed by Tacitus to the Germans, from whom they sprung; "De minoribus rebus principes consultant, de majoribus omnes; ita tamen, ut ea quoque, quorum apud plebum arbitrium est, apud principes pertractantur." See *Borough*.

It has been, among constitutional antiquarians, an interesting question, whether they who possessed this quantity of land had thereby the right of being in the wittena-gemote; or whether the members of this great council were elected from the territorial proprietors, and sat as their representatives? One person is mentioned by Mr. Turner (*ubi infra*),

whose

whose designation seems to have the force of expressing an elected member. Among the persons signing to the act of the gemote at Clofeshoe in 824 is, "Ego Beonna *electus* consent. et subscrib."

The members of the gemote were convened by the king's writ, of which many instances occur; and the times of their meeting seem to have been usually the great festivals of the church, as Christmas, Easter, and Whitsuntide; but of these Easter, being most frequently mentioned, seems to have been the favourite period. Their meetings, however, were not absolutely restricted to these seasons. The place of their assembly was not fixed. Perhaps this might depend on the king's residence at the time, and might have suited his convenience. Our monarchs seem to have maintained their influence in the wittena-gemote by their munificence. The king presided at this council, and sometimes, perhaps always, addressed them. In 993 we have an account of a royal speech. One of their duties was to elect the sovereign, and to assist at his coronation. Another was to co-operate with the king in making laws. The wittena-gemote appears also to have made treaties jointly with the king. Many instances occur to this purpose. The treaty, printed in Wilkins's *Leges Anglæ-Saxonicæ*, p. 104, is said to have been made by the king and his witan. They are also mentioned as assisting the king in directing the military preparations of the kingdom. Impeachments of great men were made before the wittena-gemote. At these councils grants of land were made and confirmed; and the wittena-gemote frequently appears in the Saxon remains, as the high court of judicature of the kingdom, and it exercised power over the public guilds of the nation. The lands of the Anglo-Saxons, the burghs, and the people, appear in all the documents of our ancestors, as subjected to certain definite payments to the king as to their lords; and by a custom, whose origin is lost in its antiquity, among the Anglo-Saxons, all their lands, unless specially exempted, were liable to three great burdens, the building and reparation of bridges and fortifications, and to military expeditions. But what we now call taxation seems to have begun in the time of Ethelred, and to have arisen from the evils of a foreign invasion. Thus the payment of 10,000*l.* to the Danes to buy off their hostility, mentioned by Henry of Huntingdon, and those which followed, are stated to have been ordered by the king and the wittena-gemote. Under sovereigns of feeble capacity, the wittena-gemote seems to have been the scene of those factions, which always attend both aristocracies and democracies, when no commanding talents exist to predominate in the discussions, and to shape the council. Turner's *Hist. of the Anglo-Saxons*, vol. ii. book 10. Littelton's *Hist. Henry II.* vol. iii.

WITTENBERG, in *Geography*, a town of Saxony, and capital of a circle or district, situated on the side of the Elbe, over which is a ferry: it is the head town of the electoral circle, the seat of an aulic judicature, of the assize, as also a consistory, together with that of the general superintendency of the electoral circle, a spiritual inspection, the circle amt, and a famous university, founded in the year 1502, at which, in 1517, the Reformation took its rise by means of Martin Luther. This town is not large, but fortified. The old citadel was formerly the electoral residence; near it stands an arsenal. In the large round tower are kept the archives of the electoral and princely houses. The university library is kept in what was formerly an Augustine cloister. The first founder of the town of Wittenberg was Bernard, duke of Saxony. In the year 1547, it was taken by the emperor Charles V.; in the year 1756, it was possessed by the Prussians, who also broke down a

bastion of the fortifications; 60 miles N. of Dresden. N. lat. 51° 53'. E. long. 12° 46'.

WITTENBERG, a town of Prussia, in Natangen; 8 miles N. of Heilberg.—Also, a town of the duchy of Lauenburg, on the Elbe; 8 miles W. of Lauenburg.

WITTENBERGEN, a town of Brandenburg, in the Mark of Pregnitz; 6 miles S.S.W. of Perleberg. N. lat. 53° 2'. E. long. 11° 50'.—Also, a town of the duchy of Holstein; 8 miles S.W. of Lutkenburg.

WITTENBURG, a town of the duchy of Mecklenburg; 17 miles W. of Schwerin.

WITTENHALL, a township of England, in Staffordshire; 2 miles N.E. of Wolverhampton.

WITTENHAUSEN, a town of the duchy of Holstein; 5 miles W. of Oldeburg.

WITTENSTEIN, a town of Prussia, in the province of Natangen; 10 miles S.S.E. of Königsberg.

WITTGENAU. See WITGENAU.

WITTHOEC, a town of Africa, in the country of Cape Lopez Gonfalso; 30 miles N. of Olibato.

WITTICHSTHAL, a town of Saxony, in the circle of Erzgebirg; 7 miles S. of Schwartzenberg.

WITTINGEN, a town of Westphalia, in the principality of Luneburg Zelle; 27 miles E. of Zelle.

WITTLÉSEE MERE, a lake of England, in the county of Huntingdon; 4 miles S. of Peterborough.

WITTLICH, a town of France, in the department of the Rhine and Moselle; 16 miles N.E. of Treves. N. lat. 50° 4'. E. long. 6° 52'.

WITTMUND, a town of East Friesland, on the Harle; 7 miles S.E. of Eßens.

WITTOBA, in *Hindoo Mythology*, is a name of the god Vishnu in one of his numerous *descents*, or *avatars*, as they are called. Some account of these avatars is given under our article VISHNU. This, now under consideration, was one of inferior importance; and not, it is said, of very ancient occurrence, and therefore not described in the Puranas, unless it be in the one supposed to be more modern than the rest, which is entitled Maha Bhagavat. (See PURANA, and SRI BHAGAVATA.) A splendid temple is dedicated to the worship of Wittoba, or Vishnu, at Panderpoor, a town of great respectability on the river Beemah, about 100 miles to the south-eastward of Poona. The manifestation is said to have taken place there. He is there represented sculptured in stone, of the size of a man, standing with his feet parallel to each other; his hands upon his hips, the fingers pointing forward, his thumbs backward. Two of the wives of Vishnu in his avatars of Krishna accompanied him in this; these were Rukmeni and Satyavama, and they have smaller temples at Panderpoor, besides their lord's. (See KRISHNA, RUKMENI, and SATYAVAMA.) Images of Wittoba are common in the Mahratta country, generally of clumsy manufacture. Several representations of Wittoba and his wives are given in the Hindoo Pantheon, from casts and pictures. That work contains also a history of the avatars, and many particulars respecting it.

WITTORF, in *Geography*, a town of Germany, in the county of Verden; 10 miles S.S.E. of Rotenburg.

WITTOW, a town on a peninsula at the northern extremity of the island of Usedom, near Artona, an ancient fortress destroyed by the Swedes. N. lat. 54° 44'. E. long. 13° 27'.

WITTSTOCK, a town of Brandenburg, in the Mark of Pregnitz; 47 miles N.N.W. of Berlin. N. lat. 53° 10'. E. long. 12° 39'.—Also, a town of Brandenburg, in the New Mark; 12 miles N. of Custrin. N. lat. 52° 49'. E. long. 14° 50'.

WITWALL, in *Ornithology*, a common English name for the great spotted wood-pecker, the *picus varius major* of authors.

WITZELRODE, in *Geography*, a town of Germany, in the county of Henneberg; 3 miles E.N.E. of Salzen-gen.

WITZELSTORFF, a town of Austria; 4 miles S.E. of Hoffmarckt.

WITZENBURG, a town of Westphalia, in the bishopric of Hildesheim; 6 miles S.E. of Alfeld.

WITZENHAUSEN, a town of Germany, in the principality of Hesse Rhinfels; 13 miles E. of Cassel. N. lat. $51^{\circ} 10'$. E. long. $9^{\circ} 48'$.

WIVELISCOMBE, a large market-town in the hundred of West Kingsbury, and county of Somerset, England, is situated in a valley, at the distance of 11 miles W. from Taunton, 25 miles W. from Somerton, and 156 miles W. by S. from London. It appears to have been of some note under the Romans, though not distinguished in their annals as a station or military post. In the earlier part of their transactions in this island, they had a large castrum, or encampment, on a hill about a mile eastward from the town, which still is called the castle. Its summit contains about twelve acres; and though mostly covered with coppice-wood and bushes, the vestiges of fortifications, and the foundations of buildings, are yet discernible on its surface. Part of the fosse, which is very deep, and extended round the hill, has been destroyed by the working of a quarry. Near the centre of the area, a great number of Roman coins of various emperors were discovered in the beginning of the last century. The Danes, during their incursions into this county, availed themselves of this castle, and after their departure, the Saxons, recovering their tranquillity, transplanted themselves to the adjacent vale, and gave their new habitations the name of Wiveliscombe. From this time it progressively became of importance, constituted the head of a large lordship, and was always held by the Saxon kings, till Edward the Confessor granted all the lands to the church of Wells. The bishops of that see had a stately palace here for nearly three centuries: it is now in ruins; a workhouse, erected in 1735, occupies a part of the ancient site. The town now consists of seven irregular streets: it is governed by a bailiff and portreeve, who are annually chosen in May. Here were formerly two markets, one on Tuesdays, the other on Saturdays; the latter only is now retained, with three annual fairs. A considerable woollen manufacture has been carried on for more than two hundred years, and still flourishes; the chief articles made are, blanketings, knap-coatings, kerseys and other coarse cloths, shrouds, ermine, and baize. Many of these are sent to London, Bristol, and Exeter, for home consumption, and for exportation to Spain and Guernsey. The church is a plain structure, and consists of a nave and two aisles, with a tower and spire at the west end. The parish besides the town includes four small hamlets, and according to the population return of the year 1811 contains 567 houses, and 2550 inhabitants.—Collinson's History, &c. of Somersetshire, vol. ii. 1791.

WIVENHOE, a village of England, in the county of Essex, situated on the river Coln; it is the harbour of Colchester, and here is a custom-house. The oysters, called Colchester oysters, are barrelled in this place. In 1811, the population was 1046.

WIZE, a river of England, in the county of Cumberland, which runs into the Wever.

WIZNA, a town of the duchy of Warsaw; 88 miles N.E. of Warsaw.

WIZUNY, a town of Lithuania; 20 miles N.N.E. of Wilkomiers.

WIZZARD, in *Agriculture*, a term applied in Norfolk to any particular sort of cart for farm-work.

WIZZENED, a term provincially applied to signify withered or shrivelled, as hay.

WLADISLAW, in *Geography*, a town of Moravia, in the circle of Iglau; 12 miles S. of Meferitsch.

WLADISLAW, or *Inowroslaw*, a town of the duchy of Warsaw, and capital of a palatinate of the same name, on the Vistula: the see of the bishop of Cujavia, removed from Kruswica in 1173; 108 miles N.W. of Warsaw. N. lat. $52^{\circ} 35'$. E. long. $18^{\circ} 35'$.

WLODOWA, a town of Austrian Poland; 18 miles N.E. of Chelm.

WLODZIMIERZ, a town of Poland, in Volhynia, on the Bog; the see of a Greek bishop, united to the church of Rome; 48 miles W. of Luckow.

WOAD, in *Agriculture*, a plant cultivated in the field for the use of the dyers. It is a plant which has a strong thickish fibrous root, which penetrates deep into the soil, and which is principally raised for the use of the leaves, which, after being properly manufactured, are made use of in the art of dyeing to produce a blue colour, as well as the basis of black, and some others.

Soil.—It is evident from the nature of its root that it requires a soil which has much depth or staple, and which is perfectly fresh, such as those of the rich, mellow, loamy, and deep vegetable kind. Where this sort of culture is carried to a considerable degree of perfection, as in Lincolnshire, the deep, rich, putrid, alluvial soils on the flat tracts extending upon the borders of the different large rivers are chiefly employed for the growth of this sort of crop; and it has been shewn by repeated trials that it answers most perfectly when they are broken up from a state of sward immediately for it. In some places, it is the practice to take lands of this description at high prices, for the purpose of breaking them up and growing it upon them for two or three years; on the more low rich soils, for four years, but on those of less fertility only for three; and in some, which are more elevated and exposed, two are considered sufficient. For this sort of culture, people are employed, who move from place to place, and form a sort of colony. Mr. Cartwright, in the above county, has however found, that it is capable of being confined to one spot with equal or greater success, by having a sufficient extent of ground for changing the place of its growth as may be necessary, and for appropriating an adequate proportion annually to the raising of the plant, by which the houses and expensive machinery that are necessary for its preparation may be kept constantly and regularly employed in the business.

Preparation.—In order to prepare the land for this crop, it is advised by some to plough it up with a good deep furrow, immediately before the winter commences, laying it in high narrow ridges, to have the full effect of the frosts; and early in the spring to give another ploughing in the contrary direction, leaving the ground in the same kind of ridge as before. When it has remained in this state some length of time, and weeds appear, it should be well harrowed down with a heavy harrow, repeating the operation so as to render it perfectly fine and clean. About the beginning of June a third ploughing should be given to the full depth with a narrow furrow, and the land be afterwards well harrowed down as before; the fourth or final ploughing being given towards the beginning of July, in a light manner, leaving the surface as even as possible for the seed. But some take much less trouble in the business of preparation.

tion. In cases where the soils are sufficiently dry, only breaking them up early in the month of February; and where the contrary is the case, deferring it to a later period, taking care to plough the land in a perfect manner to the depth of five inches, or more; and that the furrow-slices may be well turned, laid flat, and nicely jointed, a person is employed with a spade for the purpose of adjusting them. This prevents the grassy matters from rising in the seams. When this has been done, the surface is repeatedly harrowed over, to raise a sufficient depth of good mould for the drill to work in; and before the seed is put in a roller is passed over the land.

It is probable, however, that this method is inferior to the former, as the land is not brought nearly to so fine a state of mould, or the grassy material so effectually covered and destroyed, from which injury may be done to the woad plants in their early growth.

But a method which is equally effectual with the first, more expeditious, and which has a superiority over it, in more completely destroying grubs, insects, and other vermin, which are apt to feed on the plants in their early growth, is that of paring and burning. This is, however, chiefly practised where the sward is rough, and abounds with rushes, sedge, and other plants of the coarse kind, but might be had recourse to on others, with vast benefit.

Where the latter modes are made use of as soon as the seed has been put in, the land should be carefully drained by forming grips in suitable directions, as wherever water stagnates, the woad plants are liable to be injured or destroyed.

Seed.—In respect to the seed, it should be collected from ground that has been left covered with the best plants from the preceding season, as they only run up to stem and form seeds in the second year; and in order to have good seed, the leaves should not be cropped at all or but once, the stems being suffered to remain till the seeds in the husks become perfectly ripened; which is shewn by their attaining a brownish-yellow colour, and the pods having a dark blackish appearance. It should then be gathered as soon as possible, by reaping the stems in the manner of grain, and then spreading them in rows thinly upon the ground if the weather be fine, when in the course of a few days they will be in a state to be threshed out from the husks or pods. When they are suffered to remain too long, the pods are liable to open, and shed the seed. Although the pod in which the seeds are contained is of a large size, the seeds are less than those of the turnip. New seed, where it can be procured, should always be sown in preference to such as has been kept for some time; but when of the latter kind, it should be steeped for some time before it is put into the ground.

In regard to the quantity of seed which is necessary, it must be regulated by the soil, and the manner in which it is sown. Where the drill is employed, less will be required than in the broad-cast method. It has been found that a rood of land, where the crop is good, will in general afford seed sufficient for eight or ten acres; and in some cases, in the broad-cast method, five or six bushels are made use of to the acre. In Kent they use ten or twelve pounds to the acre.

Sowing.—The time of sowing crops of this nature must be regulated, in some degree, by the mode of preparation that has been employed. Where the first of the above methods has been followed, it will be much later than in the other cases. But early sowing is in general to be preferred, as there will be less danger of the plants being injured by the attacks of the fly or grub. Where the weather is suitable, and the land in a proper state of preparation, the

seed may be sown in the latter end of February or March, continuing the sowings, in different portions of land, till about the middle of May, at suitable intervals of time to vary the times of cropping the leaves of the plants. The late sowings are commonly executed about the latter end of July, or early in the following month at the farthest.

With respect to the manner in which the seed is sown, it differs according to the nature and state of preparation of the land. Where it is in a fine state of mould, the drill or row method is the method mostly practised, which is by much the best, as by it the plants may be kept more easily clean and free from weeds, becoming more strong and vigorous, from the earth being more stirred about the plants: but where the contrary is the case, the broad-cast mode is generally followed; but which does not by any means admit of the plants being kept so free from weeds, or the mould so well stirred about the roots of them.

Where the first method is had recourse to, the seed is sown by a drilling-machine, such as is used for turnips, in equidistant rows, eight or nine inches apart, covering it in, either by means of a harrow attached to the implement, or by passing a light common harrow over the ground afterwards, once in a place, raking off any clods that may be present to the sides, or into the furrows: but in the latter mode, it must be dispersed by the hand in as equal a manner as possible, over the whole of the land, being then barrowed in by a light harrow, so as to leave the land in as even and level a state as possible. The ground is frequently rolled afterwards, that the surface may be left as even as possible.

In favourable seasons with good seed, the plants mostly appear in the course of a fortnight, when much attention should be paid to see that they are not destroyed by the turnip-fly, or the frosts in those of the more early sowings; as, where that is the case, the land should be immediately re-sown; as in some cases it is not uncommon to sow the greatest part of the crop two or three times over. In the very late sowings, where the crops rise thin on the ground, it is sometimes a practice to give a better plant by forming holes with a hoe in the vacant spots, and directing seeds to be dropped into them by the hand by women or children. This is the case with the late spring-sowings till the beginning of June, or a later period.

Culture while growing.—From much of the goodness of the woad plants depending on the luxuriance of their growth, and the thickness of their leaves, it is necessary to bestow great attention in the culture of the crop while growing. It is advised that the spring-sown crops, as well as those that are sown in the latter part of the summer, should have the first hoeings given them as soon as the plants are fully distinguishable above the ground, as by this means the weeds will not only be prevented from retarding the vegetation of the plants, but these by being thinned out to greater distances be more at liberty to advance and become vigorous in their first or early growth, which is a matter of much consequence to the success of the crop; and second hoeings should be given in the course of four or five weeks afterwards, when the plants should be thinned out to the full distances at which they are to stand, which may be six or seven inches, or more, according to the goodness of the soil, constantly leaving sufficient room to prevent the plants from being in any way crowded. The work is sometimes executed in much the same manner as for turnips, by hand-hoes; but in others by small short spuds, used with one hand, while the other is employed in clearing away the weeds; the labourers, mostly women and children, kneeling while they perform the work. When this work has been done, nothing further is necessary till the first cropping of the

the leaves has been performed, when the plants should be again immediately well weeded; and after each cropping the same operation be had recourse to; the extent of crop cleared in the day being, in most cases, weeded before night.

With the late-sown crops, after the second weeding in October, nothing further will be requisite till the spring, about the middle of April, when the work should be again well executed, the mould being completely stirred about the roots of the plants, that they may derive the fullest benefit from the operation. This will be sufficient to keep them clean till the taking of the first crop; after which they must be again weeded, and the same operation be had recourse to after each cropping of the leaves, as in the above case.

In respect to the business of gathering the crops with the spring-sown ones, the leaves will generally be ready to be gathered towards the latter end of June, or beginning of July, according to the nature of the soil, season, and climate; but for those put in at a later period in the summer, they are often fit to be gathered earlier. This business should, however, constantly be executed as soon as the leaves are fully grown, while they retain their perfect green colour, and are highly succulent; as when they are left till they begin to turn pale, much of their goodness is said to be expended, and they become less in quantity, and of an inferior quality for the purposes of the dyer. In favourable seasons, where the soils are rich, the plants will often rise to the height of eight or ten inches; but in other circumstances they seldom attain more than four or five: and where the lands are well managed in the culture of the plants, they will often afford two or three gatherings, but the best cultivators seldom take more than two, which are sometimes mixed together in the manufacturing of them. It is necessary that the after-croppings, when they are taken, are constantly kept separate from the others, as they would injure the whole if blended together, and considerably diminish the value of the produce. It is said that the best method, where a third cropping is either wholly or partially made, is to keep it separate, forming it into an inferior kind of woad.

Upon an acre of land, when well managed, in favourable seasons, the produce is mostly from about a ton to a ton and a half. The price varies considerably; but for woad of the prime quality, it is often from twenty-five to thirty pounds the ton, and for that of an inferior quality six or seven, and sometimes much more.

Seeding-Crops.—With such parts of the crops as are reserved for seed, it is a practice with some to crop the leaves two or three times the first year, and then leave the plants to run up to seed in the following one; but it is a better practice to only remove the side-leaves, as in this way the plants are less weakened, and the produce of the seed much increased. The plants are likewise sometimes fed down by sheep during the winter season; but this, from its tendency to weaken them, is equally improper and prejudicial.

Preparation of for the Dyer.—The woad, after it has been gathered, undergoes several processes to prepare it for the dyer; but in the improved method it is conveyed in one-horse carts, so contrived as to be lifted from the axis, and, by folding doors in the bottoms, to discharge their contents upon the floor above the mill, on being hoisted up to their proper situation: round this floor holes are formed for putting the plants down through, in order that they may drop under the grinding-wheels. The mills for this purpose have several wheels for grinding the plants, which have less diameters on one side than the other, and are about three feet in width, being constructed with iron bars for

crushing the woad. They are wrought by horses, or any other power, as may be the most convenient. The materials are preserved under the grinding-wheels by proper contrivances, which, as soon as they are sufficiently reduced, force it out of the tracks upon the stone floors on the sides; thus making way for new parcels without the mill being stopped. The bruised woad is then thrown into rooms on the sides of the mill, destined for its reception, by means of shovels. In these it remains till the juice is so much drained off as to leave it in a proper condition for being formed into balls; which is done by labourers, with apparatus for the purpose, and then laid upon trays to be conveyed to the drying ranges, in which they are placed upon grating-shelves that slide on sledges in the drying-houses. These are placed on the sides of galleries, for the convenience of being easily deposited upon them and removed again. It is kept in these till it is sufficiently dried to be laid up in other rooms, until the whole of the crop has undergone the same operations, and the workmen are ready to manufacture it.

It is stated in the Corrected Lincolnshire Report on Agriculture, that to prepare it for use in the art of dyeing, it is necessary for it to take on a proper state of fermentation, which is accomplished in the course of seven or eight weeks, and, in the technical language of the art, is termed *couching*. It is effected by regrinding the balls, in the same mill as before, to a fine powder, and then spreading it upon the floors of the rooms in which the balls were formed, to the thickness of about three feet; where it is then moistened with water, so as to keep it in a proper flow state of fermentation; and so managed by turning that it may pervade the whole in an equal manner. In this business, the direction of an experienced workman is necessary. In the turning, it is of much importance that the parts of the materials be perfectly divided, which can only be effected by a nice management of the shovel: and it is added that much advantage has been found in the goodness of the woad, from the drying and storing of it being performed in a careful manner. When this attention is neglected, the woad will not, on being broken between the finger and thumb, draw out into fine hair-like filaments, or, in the technical language of the manufacturer, *beaver* well; as the use of this substance in the blue vat of the dyer, is not merely to afford the colour of the plant, but, by bringing on a very gentle fermentation, excite the indigo in the same vat to yield its colouring principle more perfectly. This is even necessary for its own colouring-matter being fully imparted. The substance should, therefore, be so prepared in the different operations as to produce this effect in the most certain and perfect manner. When the heat in the process of couching has gone too far, the substance will be what is termed *foxy*; and when it has not proceeded to a sufficient degree, it will be what is called *heavy*. If the material be good, it does not soil the fingers on being rubbed between them; but such as is heavy does. In the conclusion of the process, the cooling is effected in so gradual a manner, as to render it not fit for taking on the same process; and of course proper being preserved in casks, or in any other way. It is then ready for use.

The preparation of woad for dyeing, as practised in France, is minutely described by Astruc, in his Memoirs for a Natural History of Languedoc. The plant puts forth at first five or six upright leaves, about a foot long, and six inches broad: when these hang downwards, and turn yellow, they are fit for gathering: five crops are gathered in one year. The leaves are carried directly to a mill, much resembling the oil or tan-mills, and ground into a smooth paste. If this process was deferred for some time, they

they would putrefy, and send forth an insupportable stench. The paste is laid in heaps, pressed close and smooth, and the blackish crust, which forms on the outside, reunited if it happens to crack: if this was neglected, little worms would be produced in the cracks, and the woad would lose a part of its strength. After lying for fifteen days, the heaps are opened, the crust rubbed and mixed with the inside, and the matter formed into oval balls, which are pressed close and solid in wooden moulds. These are dried upon hurdles: in the sun, they turn black on the outside; in a close place, yellowish, especially if the weather be rainy: the dealers in this commodity prefer the first, though it is said the workmen find no inconsiderable difference betwixt the two. The good balls are distinguished by their being weighty, of an agreeable smell, and when rubbed of a violet colour within. For the use of the dyer, these balls require a farther preparation: they are beat with wooden mallets, on a brick or stone floor, into a gross powder; which is heaped up in the middle of the room to the height of four feet, a space being left for passing round the sides. The powder, moistened with water, ferments, grows hot, and throws out a thick fetid fume. It is shovelled backwards and forwards, and moistened every day for twelve days; after which it is stirred less frequently, without watering, and at length made into a heap for the dyer.

The powder thus prepared gives only brownish tinctures, of different shades, to water, to rectified spirit of wine, to volatile alkaline spirits, and to fixed alkaline lixivium: rubbed on paper, it communicates a green stain. On diluting the powder with boiling water, and after standing some hours in a close vessel, adding about one-twentieth part of its weight of lime newly slacked, digesting in a gentle warmth, and stirring the whole together every three or four hours, a new fermentation begins, a blue froth arises to the surface, and the liquor, though it appears itself of a reddish colour, dyes woollen of a green, which, like the green from indigo, changes in the air to a blue. This is one of the nicest processes in the art of dyeing, and does not well succeed in the way of a small experiment.

Astruc proposes the manufacturing of fresh woad leaves in Europe, after the same manner as the indigo plant is manufactured in America; and thus preparing from it, a blue fecula similar to indigo, which from his own experiments he has found to be practicable. Such a management would doubtless be accompanied with some advantages, though possibly woad so prepared might lose those qualities which now render it, in a large business, preferable on some accounts to indigo, as occasioning greater dispatch when once the vat is ready, and giving out its colour less hastily, so as to be better fitted for dyeing very light shades. Neumann's Chem. by Lewis, p. 437, &c.

The ancient Gauls and Britons used to dye or stain their bodies with this plant, and were probably led from this application of it to use it for dyeing cloth.

Some hold that it was from this plant glass took its denomination; though others derive both *glass* and *glastum* from the British *glafs*, which to this day denotes a blue colour. See GLASS.

A woad blue is a very deep blue, almost black; and is the base of so many sorts of colours, that the dyers have a scale, by which they compose the divers casts or degrees of woad, from the brightest to the deepest.

WOAD, in *Botany*. (See ISATIS.) There are four species.

The broad-leaved woad is cultivated in several parts of

England for the purposes of dyeing, being used as a foundation for many of the dark colours.

Some feed down the leaves of woad in winter with sheep; a practice which Mr. Miller condemns.

Woad grows wild in some parts of France, and on the coasts of the Baltic sea: the wild woad, and that which is cultivated for the use of dyers, appear to be of the same species.

Beside the plant properly signified by the name woad, which dyes a blue colour, we have two others known in our English herbals under that name, as also that of *wold* or *weld*. These are both called by the common people *dyer's weeds*, and are the *luteola* and the *genista tinctoria*.

The ancients confounded all these three plants also under the same names. Paulus Ægineta seems to make them all the same plant; and Neophytus, speaking of the *isatis*, or our woad, properly so called, says, that it was called by the Latins *lutum*. This *lutum* has been by some understood to mean the *luteola*, and by others the *genista tinctoria*; but the latter opinion only is right, for it is described to us by the ancients as having leaves like the *linum*, or flax, and flowers like the broom.

WOAD-Mill and House, that sort of mill and house which is necessary and proper for preparing and fitting this kind of substance for the use of the dyer. The representation of a mill and excellent apparatus for effecting the preparation of the woad plant, which is made use of by Mr. Cartwright, with much success and advantage, in Lincolnshire, may be seen in the second volume of the "General Dictionary of Agriculture and Husbandry."

WOAHOO, or OAHOO, in *Geography*, one of the Sandwich islands; as far as could be judged from the appearance of the north-east and north-west parts, it is much the finest island of the whole group. Nothing can exceed the verdure of the hills, the variety of wood and lawn, and rich cultivated valleys, which the whole face of the country displayed. The road is formed by the north and west extremities. Should the ground-tackling of a ship be weak, and the wind blow strong from the north, to which quarter the road is entirely open, this circumstance might be attended with some danger; but with good cables there would be little risk, as the ground from the anchoring-place, which is opposite to the valley through which the river runs to the north point, is a fine sand. This island is supposed to contain 60,000 inhabitants. N. lat. 21° 43'. E. long. of the anchoring-place 202° 9'. See SANDWICH ISLANDS.

WOALDS, in *Agriculture*, a term not infrequently applied by writers on husbandry to crops of the woad kind. See WOAD.

WOAPO, in *Geography*, one of the Ingraham islands in the Pacific ocean. Captain Ingraham called it Adams. It was afterwards visited by captain Roberts, who named it Jefferson. S. lat. 9° 27'.

WOBBEL, a town of Westphalia, in the county of Lippe; 6 miles E.N.E. of Horn.

WOBURN, or WOBBURN *West*, or *Bishop's Woburn*, a village in the hundred of Delsborough, Buckinghamshire, England, is situated in a narrow valley, at the distance of 3 miles W.S.W. from Beaconsfield, and 26 miles W. by N. from London. The manor of Bishop's Woburn had from time immemorial belonged to the see of Lincoln, till the year 1547, when bishop Holbeach gave it to the crown in exchange. It was granted in 1549 to John, earl of Bedford. In the 17th century it came by marriage to Philip, lord Wharton, whose son and grandson, the celebrated marquis and duke of Wharton, successively held it. After the death of the latter, it was sold to the Berties; from whom it was purchased, in 1784, by Mrs. Dupré, mother

mother of James Duprê, esq. of Wilton-park, who is the present proprietor. The old manor-house was a palace of the bishops of Lincoln, several of whom died here. The marquis and the duke of Wharton are said to have expended incredible sums of money on the house and gardens: of the latter, which in a former age were highly celebrated, scarcely a vestige now remains. The mansion was pulled down in 1750; when one of the wings was fitted up as a dwelling-house, which has since been enlarged and improved, and is now occupied by the countess of Orkney. The parish-church is a spacious and ancient structure, with a nave, two aisles, and a tower. The latter was built about the year 1480, as appears by the epitaph of John Goodwin and Pernell his wife, who are called its founders. In the chancel are several monuments of the families of Bertie and Wharton, among which is one of grey marble to the memory of Philip, lord Wharton, who died in 1695. The font is a curious piece of ancient sculpture. This parish contains 2596 acres, chiefly disposed in arable and wood land. In the population return of the year 1811, the inhabitants were estimated at 1604; the number of houses at 318. An annual fair is held, for which lord Wharton obtained a charter in 1686. A fair was also granted by king Henry VI., but is now discontinued.—*Beauties of England and Wales*, vol. 1. Buckinghamshire. By J. Britton and E. W. Brayley, 1802. *Lycens' Magna Britannia*, vol. 1. Buckinghamshire, 1806.

WOBURN, or *Old Woburn*, a market-town in the hundred of Manshead, and county of Bedford, England, is situated near the western confines of the county, at the distance of 14 miles S.W. by S. from the county-town, and 42 miles N.W. by N. from London. Great part of the town was consumed by fire in 1724, which, though distressing to individuals, proved ultimately beneficial, as the houses were rebuilt in a more convenient and regular manner, with the addition of several good inns, and a market-house. The whole expence of the new buildings was defrayed by the duke of Bedford. The market-house was finished in 1737, but has been materially improved by the late duke Francis. It consists of two floors; the lower fitted up for butchers' shambles, over which is a spacious room for a corn-market. In the population return of the year 1811, the inhabitants of the parish are stated to be 1506, occupying 299 houses. A weekly market is held on Fridays, which was granted in 1242 to the abbot of Woburn, and four fairs annually. The church was erected by Robert Hobbs, the last abbot of Woburn. This structure furnishes a peculiar instance of capricious taste; the body being completely detached from the tower, which stands at about six yards distance. The tower is a small square building, with large buttresses at the corners, and four pinnacles; the church consists of three aisles and a chancel; the whole has recently undergone a thorough repair. Adjoining to the church-yard is a free-school, founded by Francis, earl of Bedford. Here are also alms-houses for twelve poor persons, founded by the Bedford family, and endowed with 50*l.* per annum, which was confirmed by act of parliament in 1761.

About a mile east of the town is Woburn abbey, the seat of the duke of Bedford. This magnificent mansion is situated in the midst of an extensive park, and occupies the four sides of a quadrangle of more than 200 feet. It was erected about the middle of the last century by Flitcroft, for John, the fourth duke of Bedford, of the Russel family, on the site of an old abbey. The original building was founded in the year 1145, by Hugh de Bolebec, for monks of the Cistercian order. In 1234 the monastery was so reduced, that the establishment was for a time broken up,

and the monks dispersed into different convents till their debts were paid. But by various benefactions their revenues were so much improved, that at the general dissolution they were estimated at 391*l.* 18*s.* 2*d.* clear yearly value. The last abbot was hanged for denying the king's supremacy. The site of the abbey was granted in 1547 to John, lord Russel, afterwards earl of Bedford, and has ever since been the principal seat of that noble family. There are no remains of the conventual buildings. The present mansion, originally fitted up in a very costly style, has received many considerable improvements, particularly during the time it was in the possession of the late duke. Mr. Holland, the architect of Drury-lane theatre, has displayed much taste and ability in the additional buildings which have been executed under his direction. The west front is built of the Ionic order, with a rusticated basement. The principal floor, or suite of rooms on this side, consist of a saloon, state bed-rooms, drawing and dining-rooms; the south side contains the library, breakfast, Etruscan, and duke's rooms; the east, the vestibule, servants' offices, &c.; and the north, the French bed-rooms, and various other chambers. Most of the apartments are embellished with fine paintings: the gallery, in particular, exhibits a large and valuable collection of portraits by the old masters. The late duke's favourite pursuits are well known to have been experimental agriculture and breeding of cattle. For this purpose he kept several farms in his own hands. The principal of these, distinguished by the name of the Park-farm, is situated in the park, about half a mile from the house. All ingenious contrivances to shorten labour, and facilitate useful operations, are here concentrated. The farm-yard is replete with conveniences. It contains barns, stables, fatting-houses, &c.; a very complete mill, furnished with a curious machine which threshes and dresses at the same time; a maltern; two pair of stones for grinding wheat and barley; and every requisite for dressing flour, making oatmeal, &c. In another part is a small water-wheel, which gives motion to some very ingenious machinery for bruising malt, and cutting chaff. This farm originated with the late duke, through whose patronage and exertions many improvements have been made in the different branches of husbandry. The present duke follows the steps of his brother in patronising agricultural improvements, and keeps up all the establishments which he formed with a view to that purpose.—*Beauties of England and Wales*, vol. 1. Bedfordshire. By J. Britton and E. W. Brayley, 1801. *Lycens' Magna Britannia*, vol. 1. Bedfordshire, 1806.

WOBURN, a town of the state of Massachusetts, in the county of Middlesex, containing 1277 inhabitants; 15 miles N.W. of Boston.

WOCANELLY, a town of Hindoostan, in Golconda; 40 miles N.W. of Adoni.

WODEN, in *Mythology*. See ODIN.

WODERCUM, in *Geography*. See WORCUM.

WODNANY, or WODNIAN, a town of Bohemia, in the circle of Prachatitz; 12 miles N.E. of Prachatitz. N. lat. 49° 10'. E. long. 14° 2'.

WODWALLA, a town of Sweden, anciently a seaport, but now much reduced, and its privileges removed to Gotheburg, at eight miles distance.

WOEL, a town of France, in the department of the Meuse; 12 miles N.E. of St. Mihiel.

WOELFLIES, a town of Saxony, in the principality of Gotha; 21 miles S.E. of Gotha.

WOERAMATTA, a small island in the East Indian sea. S. lat. 7° 2'. E. long. 131° 36'.

WOERDEN, or WORDEN, a town of Holland, built by

by Godfrey de Rhenen, the twenty-eighth bishop of Utrecht, on the river Rhine, about the year 1160, to keep the citizens of Utrecht in subjection, and maintain his authority. It had a castle, which was formerly supposed to be impregnable; but when the French took the city in 1672, they entirely demolished it, before that time falling to decay. This city had its own particular lords till the year 1296, when Herman de Woerden fortified it, having been convicted of being a party in the murder of Florent V. comte of Holland, who was assassinated by a gentleman named Gerard de Velsen, whose wife he had ravished. It was afterwards sold by Philip II. king of Spain, to Eric, duke of Brunswick; from whom it came, in 1581, under the dominion of the States-General. In 1672, the French having made themselves masters of this place, the Dutch came to besiege it, under the prince of Orange and the comte de Zuytlestein. The comte de Marck, who commanded in the city, began to be much pressed, when the duke of Luxemburg arrived with 9000 men. He passed the morafs by a way which was supposed to be inaccessible, forced the intrenchments, and put the enemy to flight. The Dutch lost 2000 men, killed and wounded, among the former of whom was the comte de Zuytlestein; and the French about 1000; 8 miles W. of Utrecht.

WOGGORA, a small high province of Abyssinia, on the E. of Gondar, which is sown with wheat. This province and Dembea are the granaries of the country.

WOGGT, a river of Austria, which runs into the Ager, near Voglabruck.

WOLYDURGAM, a town of Hindoostan, in Myfore; 15 miles S. of Ousloor.

WOGOW, a town of Prussia; 18 miles S. of Königberg.

WOGSHAID, a town of Austria; 7 miles S.W. of Aigen.

WOHLAU, a town of Silesia, and capital of a principality, on all sides surrounded with marshes, which are a kind of natural defence. It has two suburbs, a Roman Catholic and a Lutheran church. In the year 1640, it was taken by the Swedes; in 1642, surprised by the Imperialists, but soon after retaken by the Swedes; and in 1644, recovered by the Imperialists; 20 miles N.W. of Breslau. N. lat. 51° 20'. E. long. 16° 35'.

WOHLAU, or *Wolau*, a principality of Silesia, bounded on the north by the principality of Glogau, on the east by Poland and the principality of Oels, on the south by the principalities of Breslau and Lignitz, and on the west by the principalities of Lignitz and Glogau; situated on both sides of the Oder. The soil is in some parts dry, in others marshy, or overrun with woods and bushes, though several tracts also yield good corn.

WOHRA, a river of Germany, which runs into the Werra, 2 miles N.W. of Echwegen, in the principality of Hesse.

WOHRD, a town of Bavaria, in the territory of Nuremberg, near Nuremberg.

WOINITSCH, a town of Austrian Poland; 36 miles E. of Cracow.

WOITSBACH, a town of Bohemia, in the circle of Boleslaw; 8 miles E. of Krottau.

WOITSBERG. See **VOITSBERG**.

WOKING, a town of England, in the county of Surrey; 8 miles N. of Guildford.

WOKINGHAM, or **OAKINGHAM**, a market-town and parish in the hundred of Sonning, and county of Berks, England, is situated in Windfor forest 7½ miles E.S.E. from Reading, and 32¼ W.S.W. from London. The population in 1811 was 2085 persons, inhabiting 435 houses. The market is held on Tuesday, and the fairs on the 23d of April, 11th of June, 10th of October, and 2d of November. The town, incorporated by James I., is governed by an alderman, high steward, recorder, burgeses, and a town-clerk; and at this place are held all the courts for Windfor forest. Although within the bounds of Berkshire, the church stands in an insulated part of Wiltshire: it is a large and handsome edifice. The inhabitants are chiefly employed in agriculture, throwing silk, sorting wool, and making shoes: the gauze manufacture was some years ago introduced. At Luckelygreen, near this town, is an hospital, founded in 1665 by Henry Lucas, esq. for sixteen poor men and a master: the trustees of the charity are the Drapers' company of London. About four miles S.E. from Wokingham, is a large and irregular fortification, with a double ditch, commonly called Cæsar's camp, situated on the summit of a hill. Half a mile to the southward of this camp is the Devil's ditch, a raised road nearly ninety feet wide, running east and west, with a trench on each side. In 1661 George Staverton gave the rent of a house in this place for the purpose of buying a bull, to be baited and killed at Christmas, for the benefit of the poor of Wokingham; but this being thought insufficient, the inhabitants are in the habit of purchasing another beast for the same purpose. Archbishop Laud gave a portion of certain fee-farm rents, which produces about 40*l. per annum*, to the parish. Every third year it is divided, pursuant to the donor's intention, between three poor maidens of the age of eighteen, natives of the town, and members of the church of England, who have served the same master or mistress for three years together: the other years it is appropriated to the apprenticing of poor boys. Dr. Thomas Godwin, bishop of Bath and Wells, was a native of this town, where he was born in 1517.

About four miles S. from Wokingham is Billingbear, one of the seats of lord Braybrooke. The house is a large irregular building, seated in a fine park. A particular history and description of this place is given, with a view, in Havell's *Views of Seats*, folio, 1816.—*Beauties of England and Wales*, Berkshire; by J. Britton and E. W. Brayley, London, 8vo. 1802. *Magna Britannia*, by S. and the Rev. D. Lysons, vol. 1. 4to. 1806.

WOKSCHITZ, a town of Bohemia, in the circle of Konigingratz; 2 miles W. of Gitschin.

WOLBECK, or **WALDBECK**, a town of Germany, in the bishopric of Munster; 7 miles S.S.E. of Munster. N. lat. 51° 53'. E. long. 7° 52'.

WOLBORZ, a town of the duchy of Warsaw; 41 miles S. of Siradia.

WOLCHRADITZ, a town of Moravia, in the circle of Brunn; 18 miles S.S.E. of Brunn.

WOLCKENSTEIN, a town of the duchy of Stiria; 6 miles W.N.W. of Rottenmann.

WOLCKERSDORF, a town of Germany, in the margravate of Anspach; 2 miles N. of Schwabach.—Also, a town of Austria, on the Rusbach; 8 miles E.N.E. of Korn Neuburg.

WOLCKERSHAUSEN, a town of the duchy of Wurzburg; 6 miles N. of Schweinfurt.—Also, a town of the county of Henneberg; 3 miles N. of Menungen.

WOLCOTT. See **WOOLCOTT**.

WOLCOTT, a town of Connecticut, in the county of New Haven, near Fairfield, with 952 inhabitants.

WOLD, signifies a plain, down, or open champaign ground, hilly, and void of wood.

Hence the names *Stow* in the *Wold*, and *Cotfwoold*, in Gloucester-

Gloucestershire; whence also that part of Leicestershire, which lies northward beyond the Wrekin, is called the Wold of Leicestershire.

WOLD, or *Weld*, among *Dyers*. See WELD.

WOLDEGGE, or WOLDECK, in *Geography*, a town of the duchy of Mecklenburg; 13 miles S.E. of New Brandenburg.

WOLDENBERG, a town of the New Mark of Brandenburg; 9 miles N.E. of Friedburg. N. lat. 53°. E. long. 15° 45'.

WOLEIN. See MIRZIN.

WOLESCHITZ, a town of Bohemia, in the circle of Kaurzim; 4 miles W.S.W. of Kaurzim.

WOLF, CHRISTIAN, in *Biography*, an eminent mathematician and philosopher, was born at Breslau in 1679, and well educated under able masters in different branches of literature and science. At the age of 21, he was entered at the university of Jena, which was then in high reputation; and quitting Jena in 1702, he prosecuted his studies at Leipzig, where, in the following year, he took his degree of master of arts, publishing on the occasion a dissertation, intitled "Philosophia practica Universalis Mathematico modo conscripta." In 1704 he published another dissertation, on the differential and infinitesimal calculus. Having studied theology as well as philosophy at Leipzig, he officiated as a preacher; and being invited to undertake the office of pastor in a country village, he was advised by Leibnitz to decline it, and to pursue the study of philosophy. As he commenced his literary career with great reputation, he was proposed to be an associate in the periodical work, intitled "Acta Eruditorum;" and in this connection he continued for many years, employing his leisure hours in teaching mathematics, logic, and natural philosophy. When the Swedes made an incursion into Saxony in the year 1706, he quitted Leipzig, and removed to Berlin; where a recommendatory letter of Leibnitz procured for him from Frederic I. the office of professor of mathematics at Halle. In 1709 he published, in Latin, his treatise on "Aerometry;" and in the following year his "Elements of Mathematics," in 4 vols. which have passed through several editions. Having composed a very ingenious essay on the intense cold of the ensuing winter, he was elected a member of the Royal Society of London, and soon after a member of the Academy of Sciences at Berlin. In 1711 he published his tables of sines and tangents, and in the next year his treatise on logic, in German, highly commended by Formey, and translated into Latin, French, and other languages. The first two volumes of his large work on the mathematics appeared in 1713, and these were afterwards followed by three more. By the advice of his friend Leibnitz, he refused an invitation from Peter the Great to remove from Halle to Petersburg. On the death of Leibnitz in 1726, Wolf drew up his life, which supplied Fontenelle with materials for his eulogy. In 1718 he published "Meditations on God, the World, and the Human Soul," which were reprinted in the following year. About this time the reputation of Wolf and the jealousy of his rivals occasioned a literary contest, which lasted for a considerable time, and which was not very honourable to either party. Wolf having delivered a dissertation on his quitting the pro-rectorate of Halle university in 1721, on which he took occasion to compare his own principles with those of Confucius and the Chinese, and having announced the opinion which he entertained on the doctrine of necessity, an outcry was raised against him, and he was represented by his enemies as a man whose principles tended to atheism, and to corrupt the morals of the people. Notwithstanding

this malignant attack, he employed himself in publishing three volumes of experimental philosophy, and a volume of dogmatical philosophy, which he dedicated to the emperor of Russia, and which the emperor caused to be translated into the Russian language, repeating to him the offers which had before been made, in order to induce him to remove to Peterburgh. The contest that had been excited against him still continued; and though he attempted to justify himself in a treatise on the subject of fatality, the king was at length persuaded that his principles were dangerous, and ordered him, in November 1723, to quit his territories in two days, under pain of death. Wolf immediately proceeded to Cassel, where he met with the king of Sweden, who appointed him professor of mathematics at Marburg, an office which he had refused sixteen years before. The clergy of Halle pursued him with their enmity and opposition to Marburg; but Wolf was suffered to remain in the quiet enjoyment of his office during his residence at that place. Several students who attended him at Halle followed him hither, and his lectures, which he commenced in 1724, were attended by pupils from all parts of Europe. His mind being now undisturbed, he resumed his literary labours, and published his "Remarks on Metaphysics," in which he answered the principal objections against his doctrine, and gained a decided victory over his enemies. The grounds of the censure that had been passed on Wolf had been every where canvassed; and almost every German university was inflamed with disputes on the subject of liberty and necessity, so that the names of Wolfian and anti-Wolfian were every where heard. Wolf, having thus vindicated his philosophy from reproach, received new invitations from Petersburg and Leipzig; but gratitude to his protector induced him to remain in his situation at Marburg, which he found to be very agreeable, and to afford him leisure for pursuing his speculations. After an interval of nine years, the current of public opinion turned in favour of Wolf, and he now received numerous tokens of respect from men of rank and learning; and in 1733 he was invited to fill, in the Academy of Sciences, one of the eight places allotted to foreigners distinguished in the highest branches of science. On this occasion, Reaumur and he commenced an intimate friendship, which lasted till the time of his death. The king of Prussia was convinced of Wolf's innocence, reversed his sentence of exile, and wished to repair the injury which he had sustained. He made tempting offers, both of title and money, to induce him to return to Halle; but he declined the acceptance of them; as he also refused an invitation from George I. of England to accept a place in the new academy which he had founded at Gottingen. The clergy of Halle made some other attempts to reproach and ruin him, but they recoiled on his adversaries. In the year 1740, he prefixed to the first volume of his "Droit Naturel, or Treatise on the Law of Nature," a dedication to the hereditary prince of Prussia, afterwards Frederick the Great, which was acknowledged by a very flattering letter.

Frederick the Great, as soon as he ascended the throne, recalled Wolf to Halle; and with the permission of the king of Sweden, he consented to accept the office of professor of the law of nature and nations, and also of mathematics, with a salary of 2000 crowns, and liberty to teach whatever he thought proper. He obtained also the rank of privy-counsellor, and was made first vice-chancellor, and afterwards chancellor of the university. In 1745 he was created a baron by the elector of Bavaria. Wolf was now at the height of his prosperity. At more than 60 years of age he resumed his labours, and completed his work on the law of

nature and nations, which was written in Latin, and extended to eight volumes 4to. He also wrote prefaces to the works of others, and particularly one to *Suffmilch's* work on population. Notwithstanding his great celebrity, perhaps on this account, he had many and powerful enemies. Leibnitz, Maupertuis, and Voltaire, were of this number: and with respect to the latter, we may observe, that both in his writings and in his conversation with the king, he contributed in no small degree to lessen the veneration which Frederick II. entertained for him. In 1752 he was made a member of the Institute at Bologna; but he did not long survive this honour, as he died in the month of April 1754, in the 76th year of his age. He left one son, who inherited a considerable estate which he had purchased.

The adversaries of Wolf attacked not only the principles of his philosophy, but his method and his style. His Latin, it must be acknowledged, was not elegant; but his German has been commended and imitated; and he is said to have improved his native tongue both in precision and energy. With regard to his general disposition and demeanour, he is said to have united a great degree of complaisance and affability, with irreproachable morals and excessive vanity, which he was not able to conceal. He did not hesitate to extol himself and his own merits publicly and without reserve, and even to exhibit them in emblematical devices on the titles of his books. Brueker sums up the character of Wolf as a writer in the following concise manner:—"He possessed a clear and methodical understanding, which by long exercise in mathematical investigations was particularly fitted for the employment of digesting the several branches of knowledge into regular systems; and his fertile powers of invention enabled him to enrich almost every field of science in which he laboured, with some new addition. The lucid order which appears in all his writings enables his reader to follow his conceptions with ease and certainty through the longest train of reasoning. But the close connection of the several parts of his works, together with the vast variety and extent of the subjects on which he treats, renders it impracticable to give a summary of his doctrines." Brueker's *Philosophy* by Enfield, vol. ii. Preface to M. de Vattel's *Law of Nations*. See *LEIBNITZIAN Philosophy*.

WOLF, JEROME, a German philosopher, was born in the county of Oettingen, in the year 1516, and instructed in the elementary parts of education at a college established by the senate of Nuremberg. But his studies were interrupted by an appointment in the service of Julius, the chancellor of count Von Oettingen. This interruption, however, contributed to allay the severity of his countenance and manner, and to meliorate the moroseness of his temper; whilst these unamiable qualities were amply counterbalanced by probity, diligence, and modesty, which engaged the confidence and esteem of his employer. His habitual disposition again returned, and he resumed the study of poetry, and of the ancient Greek writers, against the remonstrances of the chancellor, who recommended attention to jurisprudence and public business, as the most effectual means of acquiring both honour and competence. Remonstrances were ineffectual, and he persisted in pursuing a course which cherished his morbid melancholy and disquieting irritability. Still devoted to his literary pursuits, he was fortunate in gaining the patronage of John James Fugger; and in being afterwards advanced to the post of the director of the college of Augsburg, and that of librarian to this institution. In this situation he remained till his death, which happened in the month of October 1580. Wolf was particularly distinguished as a laborious translator, in which literary depart-

ment he gained the commendation of Huet; though Henry Stephen censures his performances. When the edition of the *Annals of Zonaras*, published by Wolf at Basle in 1557, became rare, a new one, with notes by Du Cange, was printed at the Louvre in Paris in 1687. Wolf's translation of Demosthenes was first printed at Basle by Oporinus; and being much approved, it passed through two other editions. After being revised by the translator, Episcopius printed it at Basle in 1572, with the orations of Æschines, the commentaries of Ulpian, and the notes of Wolfius. His other works, which were numerous, almost wholly related to Greek and Latin authors. *Eloges par Formey et Teiffier*.

WOLF, JOHN CHRISTOPHER, a German Lutheran divine and eminent scholar, was born in 1613, at Wernigeroda, and removing in 1695 to Hamburg, was educated under the protection of the celebrated Fabricius, by whom he was employed, under the age of 20 years, in making a catalogue of all the writers quoted in Eusebius's Commentary on Homer, afterwards inserted by Fabricius in his "*Bibliotheca Græca*." Having prosecuted his studies at Wittenberg, and graduated master of arts, he became, in 1706, adjunct of the philosophical faculty. Upon his return to Hamburg, he undertook a tour in 1708 through Holland to England, and for some time resided at Oxford for the use of the Bodleian library. His next migration to Denmark led, in 1710, to the appointment of extraordinary professor of philosophy at Wittenberg, where his lectures collected a great number of pupils. Although he was here advanced to the chair of theology, he removed in 1712 to Hamburg, and was appointed professor of the oriental languages in the Gymnasium, and in 1715 promoted to be rector of that institution. He was likewise a preacher-extraordinary at the cathedral, and became pastor of the church of St. Catharine; and soon after a member of the Academy of Sciences at Berlin. He commenced his literary contributions to the "*Acta Eruditorum*" in 1708; and he collected from various repositories an astonishing number of rabbinical and oriental books and MSS.; which library he bequeathed to the library at Hamburg, where he died in June 1739. Of his numerous works, we shall here enumerate his "*Bibliotheca Hebræa*," in 4 vols. fol.; "*Historia Lexicorum Hebraicorum*;" "*Primitiæ Flemburgenses, sive Oratio de Præcocibus eruditis, et Orationes binæ de Necessitate et Utilitate declamandi*;" "*Historia Bomogilorum*;" "*Disertatio de Atheismi falso suspectis*;" "*Curæ philologicæ et criticæ in Novum Testamentum*," 4 vols. 4to. He was also the editor of several learned works. *Gen. Biog.*

WOLF. There are biographical articles for five German musicians of that name in Gerber's Continuation of *Walther's Musical Lexicon*.

First, *Michael Christian Wolf*, organist and music director in St. Mary's church at Stettin, born 1709, and who died in 1789, after publishing the following works: "Six Duets for two German Flutes at Berlin;" "Six Harpichord Sonatas," Stettin, 1776; "Songs with a Harpichord or Harp Accompaniment," Emden, 1777; "Exercises for the Organ in Choral Music;" and having in MS. a Psalm for Four Voices, with an Accompaniment for the Organ, and many other pieces for the church and chamber.

II. *Ernst Friederic Wolf*, brother to the preceding matter, state organist at Cologne, who died in 1772. He had been two years under the chapel-master Stölz, for composition; and under the concert-master Hübn, at Gotha, for the violin. But at nine years old he had previously studied the scores of great masters, and the *Gradus ad Parnassum*

of Fouché, so that early in life he became a great extempore player on the organ.

Of these two brothers we have never heard or seen the productions; but of

Ernst William Wolf, born at a village near Gotha, in 1735, chapel-master at Weimer, we have seen and admired many of the works.

WOLF, in *Astronomy*. See **LUPUS**.

WOLF, *Lupus*, in *Zoology*, the *canis lupus* of Linnæus, a beast of prey of the dog kind, with the tail bending inwards, rather long and bushy, and the largest and fiercest of that race of animals. It is extremely like the domestic dog in shape, and if the head, which is long, with a pointed nose, did not differ a little in figure, the upper part of the face being broader, one would be apt to declare it the very same animal. It is distinguished also by superior size, stronger limbs, and more muscular body. It has a very fierce look about the face; its eyes are more obliquely placed than those of the dog, and are more glaring and savage; its jaws are much stronger; and its teeth, which are large and sharp, and the opening of its mouth, which is shorter in proportion than that of the dog, fierce and frightful. The ancients had an opinion, that the neck of the wolf was all of one solid bone; but, on the contrary, this creature is able to turn and twist it about better than the dog kind.

The wolf, as well as all the other beasts of prey, can endure hunger a long time, though very voracious when it meets with food. The wolf differs from the dog in his note, for instead of the barking of the dog this creature only howls; his ears, which stand erect, and his tail, make him also greatly resemble the fox.

The hair of the wolf is long; the legs are long; the head and neck cinereous: and the body generally pale grey, tinged with yellow; sometimes found white; in Canada sometimes black; and taller than a large grey-hound.

The wolf inhabits the continents of Europe, Asia, Africa, and America.

How numerous these animals were formerly in Britain we may infer from the laws of king Edgar, who attempted to extirpate them by commuting the punishments for certain crimes into the acceptance of a number of wolves' tongues from each criminal; in Wales by converting the tax of gold and silver into an annual tribute of three hundred wolves' heads. In succeeding times their destruction was promoted by certain rewards; and some lands were held on condition of destroying the wolves which infested those parts of the kingdom.

In 1281, these animals infested several of the English counties; but after that period, our records make no mention of them. The last wolf known in Scotland was killed in 1680, and in Ireland one was killed in 1710.

The wolves of North America are the smallest; and it is said, that from those proceeded the dogs which were found there by the Europeans on their first arrival: when reclaimed, they are the dogs of the natives. In the less inhabited parts of the country, they gather in large droves, and hunt the deer and other animals like hounds with hideous howlings, and it is affirmed that they will attack even the buffalo. In the inhabited parts, they are become rare. In some parts of Europe their number has somewhat increased; *e. g.* in Sweden they were rare till about the year 1720. The Swedes destroy them by stuffing the carcase of a sheep or other animal with a species of lichen or tree-moss, (*lichen vulpinus*), which is considered as a certain poison to the wolf, and also, as the name imports, to the fox. This is said to be mixed with pounded glass, which is probably more destructive than the lichen. The wolves of Senegal

are the largest and fiercest; and they prey in company with the lion. Those of the Cape are grey striped black; others are black.

Wolves are cruel, but cowardly animals; they fly from man, except when impelled by hunger; in which case, they prowl by night in great droves through villages, and destroy any persons they meet; and having once got the taste of human blood, give it the preference. In hard weather wolves assemble in large troops, and join in dreadful howlings. They have a fine scent, and hunt by the nose: between them and the dogs a mutual enmity subsists. This animal has a very strong carnivorous appetite; and yet crafty, strong, and nimble as he is, and in every respect capable of seizing his prey, he often dies of hunger. Being driven into the forest, he finds only a few species of wild animals, who save themselves by flight, so that he perishes with want. Although he is naturally timid and dastardly, he braves danger, when pressed with famine, and attacks those animals that are under the protection of man, and carries away lambs, small dogs, and kids, returning often to the charge, until being wounded by his pursuers, he retires to his den in the day, but issues forth in the night to his ferocious and destructive ravages. When his hunger is extreme, he attacks women and children, and sometimes darts with savage violence upon men, till at length he falls a sacrifice to his own rage. We have occasional accounts of the terror which this animal has excited, and of the destruction which he has committed among women and children in France. To such a degree did his ravages excite terror in 1764, that prayers are said to have been offered for his destruction.

Wolves, in the northern parts of the world, sometimes get on the ice of the sea, in order to prey on young seals, which they seize when asleep; but sometimes the ice detached from the shore carries them to a great distance from the land, and large districts have thus been cleared of these pernicious animals, which have been heard howling in a dreadful manner far in the sea.

The wolf is sometimes affected with madness, accompanied with symptoms similar to that of dogs; and this disease happens to them in the depth of winter, and therefore, as Mr. Pennant observes, cannot be attributed to the rage of the dog-days. The time of gestation in the wolf is, according to Buffon, about three months and a half; and the young whelps are found from the end of April to the beginning of July; and this difference in the time of gestation, being in the wolf about one hundred days, and in the dog only sixty, he considers as a proof of the real difference between the two species.

Although the wolf seems to be naturally savage, he is capable, when taken young, of being tamed, and of being wholly divested of the ferocious character of his species. Ray. Pennant. Shaw.

WOLF, *Golden*. See **JACKALL** and **AUREUS**.

WOLF, *Marine*. See **HYÆNA**.

WOLF, *Mexican*, *Canis Mexicanus*, with deflected tail and ash-coloured body, variegated with dusky bands and fulvous spots, a species that inhabits the hot parts of Mexico, agreeing in its manners with the European wolf. Its head, jaws, and teeth, are large; in the upper lips are strong bristles bent backwards, of a grey and white colour; the ears are large, erect, and cinereous, and the space between them marked with broad tawny spots; the head ash-coloured, crossed with dusky stripes; the neck fat and thick, and marked with a tawny stroke; on the breast is another of the same kind; the body is ash-coloured spotted with black, and the sides striped with the same colour; the belly

belly cinereous, the tail long, of the same colour, tinged in the middle with tawny; the legs and feet striped with black and ash-colour. This wolf is sometimes found white. Pennant.

WOLF, Black, *Canis Lycaon*, with straight tail, is considered by Buffon and others as a variety of the common wolf, and confounded by Schreber and Gmelin with the black fox; but regarded as a distinct species. It is found both in Europe and America, and in some parts of Asia. In America it is chiefly found in Canada, and in Europe in the more northern regions. Shaw.

WOLF, in the *History of Insects*, the name of a small white worm or maggot, which infests granaries, and does very great damage there.

It is in this state of the worm that it does the mischief; but this is not its perfect form, for it is afterwards transformed into a small moth, with white wings spotted with black.

This little maggot has six legs, and as it creeps along, there issues from its mouth an extremely fine thread or web, by which it fastens itself to every thing it touches, so that it cannot fall. Its mouth is furnished with a pair of reddish forceps, or biting instruments, by means of which it gnaws its way not only into wheat and other grain, but perforates even beams of wood, boxes, books, and every thing it meets with.

Towards the end of summer these pernicious insects may be seen crawling up the walls of corn-chambers, infested with them in great numbers; they are then searching a proper place where they may abide in safety during their aurelia state; for when the time of their undergoing this change approaches, they forsake their food, and the little cells they had formed of hollowed grains of corn clotted together, by means of the web coming from their mouths. They now wander about till they find some wood, or other substance into which they gnaw holes with their fangs, capable of concealing them; and there enveloping themselves in a covering of their own spinning, they soon become a dark-coloured sort of aurelia. They remain in this state all the winter; but in April or May they come forth in their moth-shape, and are then seen in vast numbers, taking short flights, and creeping up the walls. In this state they eat nothing; but they soon copulate and lay eggs, which are in the shape of a hen's egg, but no larger than a grain of sand. Each female lays sixty or seventy eggs, which she deposits in the little wrinkles of the grains of corn, where in about sixteen days they hatch, and the minute maggots immediately perforate the grain, and eat out all its substance, and with the threads which come from their mouths cement other grains to it, which they, in the same manner, scoop out and destroy.

The watchful observer has two opportunities of destroying these devourers from among his corn. One is, when they forsake their food, and ascend the walls, which they will sometimes almost cover. The other, when they appear in the moth-state. At both these times they may be crushed to death against the walls in great numbers, by clapping sacks upon them; but they may be exterminated more effectually by closing up all the windows and doors, and burning brimstone on a pan of charcoal, letting the room be full of the fumes of it for twenty-four hours. This certainly destroys the animals, and does no sort of injury to the grain, not communicating the slightest scent to it. Baker's Microf. p. 222.

WOLF's Bane, in *Botany*. See **ACONITUM**.

WOLF's Bane, Winter's, a species of *hellebore*; which see.

WOLF-Fish. See **LUPUS Marinus**.

WOLF's Grapes. See **LYCOSTAPHYLÆ**.

WOLF-Net, a term used by the sportsmen for a kind of net used in fishing, which takes great numbers, and has its name from the destruction it causes.

It is used both in rivers and ponds, and is of the nature of the rattle, excepting only the wanting of the four wings. The trunk or coffer consists of seven feet, besides the two gullets. It is supported by hoops, and is to be placed in some part where there is an abundance of sedges, rushes, and water-grafs. There is to be a place made for the net here, by the use of a paring-knife, cutting away all the weeds and other matter, for the space that will contain it; and when the net is placed, there are to be two alleys cut or cleared in the same manner, one on each side of the net, that the fish may be invited into them, and by them into the net. There must be some stones or leaden weights used to sink the net, and a long pole fastened to the upper part of the mouth of it, by means of which, when it is well filled with fish, it may be lifted up and taken to the shore.

WOLF's Peach. See **LYCOPERSICON**.

WOLF, War, an ancient military machine, differently described by different writers. Procopius makes it a kind of portcullis, or rather a harrow for defending a gate. Matthew of Westminster, and Camden, describe it as a machine for throwing stones. "At the gates," says Procopius, (Hist. of the Gothic Wars, book i.) "they set up wolves in the following manner:—They erected two beams from the ground reaching to the battlements, and laid chequerwise pieces of wrought timber, some upright and some cros; they jointed them so that the mortising holes met one another; and before each joint stuck out a pointed piece of wood, like a thick spar, and fastening the cros timbers to another beam, which from the top reached half-way down: they laid the beams flat along upon the gates, and when an enemy approached, men above laid hold of the higher ends of the beams, and thrust them down, which falling suddenly among the assailants, with the wooden points sticking out, killed all upon whom they descended." Probably there was a chain or cord to draw back the machine after it had produced its effect.

The war-wolf, for throwing stones, is described by Matthew of Westminster, ann. 1304; by Camden, in his Remains, to which we refer; and also to Grose's Mil. Antiq. vol. i. p. 383.

WOLF Island, in *Geography*, an island in the North Atlantic ocean, near the east coast of Labrador. N. lat. 53° 55'. W. long. 55° 40'.—Also, an island at the north-east end of lake Ontario. N. lat. 44°. W. long. 76° 50'.—Also, an island in the gulf of St. Lawrence, near the fourth coast of Labrador. N. lat. 50° 2'. W. long. 60° 55'.—Also, a small island in the Atlantic, near the coast of Georgia. N. lat. 31° 19'. W. long. 81° 30'.

WOLF River, or *Chickaw Bluff*, a river of Georgia, which runs into the Mississippi, N. lat. 34° 45'. W. long. 90° 42'.

WOLF Rock, a very low, flat, rocky islet, in the North Pacific ocean, surrounded by rocks and breakers, which extend some distance from it; 10 miles from the southern coast of the Prince of Wales's Archipelago. N. lat. 55° 1'. E. long. 226° 42'.—Also, a rock near the east coast of Labrador, and not far from the island called Wolf island.—Also, a rock at the entrance of the English channel; 10 miles S. of Land's-End. N. lat. 49° 58'. W. long. 5° 45'.

WOLFBOROUGH, a township of New Hampshire,

shire, in the county of Strafford, on the Winnipicogee lake, containing 1376 inhabitants; 35 miles N.N.W. of Durham.

WOLFDORF, a town of Bohemia, in the circle of Leitmeritz; 7 miles N. of Kamnitz.

WOLFENBUTTEL, a principality which lately constituted a part of the duchy of Brunswick, divided into two parts by the principality of Halberstadt, and the diocese of Hildesheim. The north part is surrounded on the north by the principality of Lüneburg and the marquise of Brandenburg, on the east by the duchy of Magdeburg, on the south by the principality of Halberstadt, and on the west by the diocese of Hildesheim. The south part is bounded on the north by the bishopric of Hildesheim and the principality of Calenberg, on the east by the diocese of Hildesheim and the Harz forest, on the south by the principality of Grubenhagen and Calenberg, and on the west by the territories of the abbey of Corvey and Calenberg. The eastern half contains under it a part of the Harz forest, the mines and salt-works which the prince held in common with the elector of Brunswick Lüneburg. In the western half of this southern part is a part of the forest of Sollinger, consisting of oak and beech, with a chain of mountains covered with woods. Thus the southern part of the principality consists chiefly of hills and woods, with little arable land; but, on the other hand, has a great plenty of timber, iron, and glass-houses, the manufactures of which are greatly admired, particularly those of looking-glasses, with a fine porcelain manufacture, and the very rich mines and salt-works in the Harz forest. The north part of the principality is more level, and produces abundance of grain, flax, and hemp, together with various kinds of pulse and fruit. Their graziery here turns to very good account, besides which it has a salt-work. The culture of silk is now followed, and premiums are assigned by the prince for the encouragement of it. The Weser, the Leine, the Inner See, and the Ocker, are the principal rivers. In this principality are 18 towns, 386 villages, and 17 sees and convents. The established religion here is Lutheranism. The country of Brunswick was anciently under lords of its own, who possessed it as their absolute and hereditary property, and derived their lineage from Ludolphus, duke of Saxony; and, consequently, by his grandmother Hafala, or Gifela, from duke Witikind, whose daughter she was. From king Henry I., grandson to Ludolphus, was descended his son Henry, duke of Bavaria, among whose issue was count Bruno, on whom the emperor Otho conferred a tract of land in Saxony, near Brunswick, namely, Melverode and Hohenwart. Count Bruno, his son, enlarged Brunswick; and his son, count Ludolphus, on the demise of the emperor Henry II., was the first that obtained the full sovereignty over Brunswick and Tanwarderode, and died in 1038. His son Egbert I. became margrave of Thuringia and Misnia; and his son Egbert II. likewise attained to those dignities. This last prince being killed in battle, in 1091, his sister Gertrude succeeded to the country of Brunswick, which country she brought to her second husband, Henry the Fat, count of Nordheim; and by their daughter Ricienza it came to her husband Lothario, count of Supplinburg, afterwards emperor. By his daughter Gertrude it descended to her husband, Henry the Magnanimous, duke of Bavaria and Saxony, and thus to the house of Welpho. The principality of Wolfenbittel was possessed of a vote among the princes, both in the college of the princes of the empire, and likewise in the diet of Lower Saxony; in each of which, by virtue of an agreement concluded in 1706, when the seniority lies in the house of

Brunswick Wolfenbittel, it precedes those of the elector of Brunswick and Lüneburg, for Zelle, Grubenhagen, and Calenberg, but otherwise comes after them; farther, the house of Wolfenbittel, when senior, obtained the joint direction of the circle of Lower Saxony. In 1807, this principality was annexed to Westphalia.

WOLFENBUTTEL, a city of Westphalia, and capital of a principality of the same name, situated in a low marshy soil, on the Ocker; it is well built and fortified. In it is a chateau, a long time the residence of the dukes, in which is a noble library containing 120,000 volumes of printed books and manuscripts. The principal church contains the sepulchral monument of the dukes. Wolfenbittel very probably owes its name to the first builder of the palace, called Wolf, or Wolfer, or Wolfhard; 24 miles E. of Hildesheim. N. lat. 52° 10'. E. long. 10° 40'.

WOLFERSDORF, a town of Saxony, in the circle of Neustadt; 4 miles S.W. of Weyda.—Also, a town of Saxony, in the circle of Neustadt; 6 miles E.N.E. of Weyda.

WOLFERSDYCK, a small island of Zealand, between North and South Beveland.

WOLFERSHEIM, a town of Germany, in the principality of Solms Braunfels; 12 miles S.S.E. of Wetzlar.

WOLFERSTORFF, a town of Austria; 2 miles S.E. of Laab.

WOLFERZHAUSEN, a town of Bavaria; 12 miles N.E. of Weilheim.

WOLFESHEAD, or **WULVERSHEAD**, Saxon, *wulfer-head*, compounded of *wulf*, *wolf*, and *head*, *head*, *caput lupinum*, denoted the condition of those outlawed for criminal matters in the Saxon time, and not yielding themselves to justice. For if they could have been taken alive, they must have been brought to the king; and if they, for fear of being apprehended, did defend themselves, they might be slain, and their heads brought to the king; for their head was no more to be accounted of than a wolf's head. LL. Edw. in Lamb. fol. 127. and Braet. lib. iii. tract. 2. c. 11. See *CAPUT Lupinum*, and *OUTLAWRY*.

WOLFESTAAL, in *Geography*, a town of Austria; 2 miles E. of Hainburg.

WOLFFBACH, a town of Germany, in the lordship of Furstberg; 4 miles S.S.E. of Hazlach. N. lat. 48° 13'. E. long. 8° 16'.

WOLFFEG, a town of Austria; 5 miles N.W. of Schwanaftadt.

WOLFFEGG, or **WOLFECK**, a chateau and village of Germany, which gives the title of count to a noble family, divided into several branches, *viz.* Wolffegg Zeil, Wolffegg Zeil Wurzach, Wolffegg Wolffegg, and Wolffegg Waldsee; 10 miles W. of Leutkirch.

WOLFFEN, a town of Saxony; 3 miles N.W. of Bitterfeld.

WOLFFPASSING, a town of Austria; 9 miles S. of Ips.

WOLFFSHAGEN, a town of Brandenburg, in the Mark of Pregnitz; 6 miles W. of Pritzwalk.

WOLFGANG, a town of Germany, in the county of Henneberg, on an island in a lake; 7 miles S.W. of Meinungen.

WOLFGANG, *St.* a town of Austria; 3 miles S.S.W. of Aigen.—Also, a town of Austria; 1 mile N. of Kirschschlag.—Also, a town of Austria, on a lake, called the Abernsea, and St. Wolfgang's lake; 54 miles S.S.W. of Lintz.

Lintz. — Also, a town of Switzerland, in the canton of Zug; 4 miles W. of Zug.

WOLFGAST, or WOLGAST, a town of Anterior Pomerania, on the Pena, about three miles from the Baltic, with about 3500 inhabitants. It was anciently a considerable fortress, and residence of the dukes; 30 miles S.E. of Stralsund. N. lat. $54^{\circ} 2'$. E. long. $13^{\circ} 45'$.

WOLFIA, in *Botany*, a genus of Schreber's, seems by its orthography intended to commemorate Dr. de Wolf, of Dantzic, of whose whimsical attempt in the NOMENCLATURE of plants, we have given a sufficient account at the conclusion of that article. This writer, to whom the praise of labour and originality cannot be denied, and whose index, entitled *Concordantia Botanica*, is truly valuable, died in 1784, aged 60. There have been several German naturalists and physicians of the name of Wolf, but none eminent in botanical studies.—Schreb. Gen. 801.—Class and order, *Oständria Monogynia*. Nat. Ord. *Tribilatae*, Linn. *Sapindi*, Juss.

Gen. Ch. *Cal.* Perianth inferior, of one leaf, coloured: tube very short, somewhat dilated at the base, permanent: limb in five deep, linear, obtuse, moderately spreading segments. *Cor.* none. Nectary of eight linear, obtuse, villous, upright scales, one-third the length of the calyx, and inserted into it at the base of the limb. *Stam.* Filaments eight, awl-shaped, erect, the length of the calyx, into which they are inserted alternately with the scales of the nectary, in the same row; anthers ovate, attached by the back, erect, directed inwards. *Pist.* Germen superior, oblong, ending in a cylindrical upright style, the height of the stamens; stigma oblong, downy, unilateral. *Peric.* Berry? ovate, of one cell, somewhat six-sided, with three keels surrounding its summit. *Seeds* three, nearly ovate, oblique, externally gibbous, contracted below the middle, abrupt at the base, enclosed in a tunic.

Obf. There appear to be several feeds, some of which prove abortive.

We have tried in vain to guess any thing more respecting this genus than its natural order, of which there can be scarcely a doubt. No author has adopted *Wolfia*. There are, in its characters, some indications of *Jambolifera*, Willd. Sp. Pl. v. 2. 326. *Cyminosma*, Gærtn. t. 58, (which ought to have found a place in our 18th volume; see CALYPTANTHES also); and a botanist who compares Schreber's description, literally translated above, with *Jambolifera pedunculata*, will find several coincidences, which, allowing for one or two easy misconceptions, might almost persuade us he had described that plant; but still there are insuperable difficulties. Schreber's index directs us, at the word *Pitumba*, to the same number as his *Wolfia*, 1749. But no such synonym occurs there, nor, as far as we can find, elsewhere in his book. *Pee tumba*, Rheede Hort. Mal. v. 9. t. 46, is a *Justicia*, and can have no connection with the present plant. See other obscure genera, thus circumstanced, at the articles MEYERA, WHELERA, SPARTINA, and XYSTRIS.

WOLF-MONETH, a name given by our Saxon ancestors to the month of January, on account of the ravages committed by the wolves in that month through the severity of the cold.

WOLFRAM, in *Mineralogy*, an ore of tungsten. (See TUNGSTEN.) The colour of Wolfram is generally a brownish or greyish-black; it gives a reddish-brown streak when cut with the point of a knife, to which it yields readily, a property characteristic of this mineral. It occurs

both massive and crystallized, and in concentric lamellar concretions. The form of the crystal is a flat rectangular prism; the lateral planes are generally streaked longitudinally. The structure is lamellar, with a very distinct cleavage in one direction, and an indistinct cleavage at right angles to the former. The lustre of the principal cleavage is splendid or shining, and is metallic; that of the indistinct cleavage is glistering. The cross fracture is coarse-grained and uneven. It is brittle and frangible. The specific gravity of Wolfram is from 7.1 to 7.3. Before the blow-pipe it decrepitates, and melts with difficulty into a black slag.

The constituent parts of Wolfram, as given by Vauquelin, are,

Tungsten acid	-	-	-	67
Oxyd of iron	-	-	-	18
Oxyd of manganese	-	-	-	6
Silex	-	-	-	1.50

Wolfram most frequently occurs in veins with tin-stone, but may be distinguished from it by its greater degree of softness, and the reddish streak which it yields to the knife. It is common in many of the mines of Cornwall, and in those of Saxony, and of Zinnweld and Schlackenwald, in Bohemia. This mineral has not hitherto been applied to any useful purpose in the arts. It was originally mistaken for antimony, which by the alchymists was called the wolf, because it appeared to destroy the baser metals in the process of refining gold.

WOLFRAMITZ, in *Geography*, a town of Moravia, in the circle of Znaym; 20 miles N.E. of Znaym.

WOLFRAMITZKIRCHEN, a town of Moravia, in the circle of Znaym; 7 miles N.W. of Znaym.

WOLFSBACH, a river of Silesia, which runs into the Bober, near Loewenberg.

WOLFSBERG, a town of the duchy of Carinthia, on the river Levant, with a citadel; 10 miles N.N.W. of Lavamunt.

WOLFSDORF, a town of Prussia, in the province of Ermeland; 18 miles W.S.W. of Heilsberg.—Also, a town of Saxony, in the circle of Neustadt; 5 miles S.W. of Weyda.

WOLFSHAGEN, a town of the principality of Hesse Cassel, on the Erpe; 15 miles W. of Cassel. N. lat. $51^{\circ} 18'$. E. long. $9^{\circ} 10'$.

WOLFSON, a small island in the gulf of Finland. N. lat. $59^{\circ} 22'$. E. long. $24^{\circ} 44'$.

WOLFSPACH, a town of Austria; 8 miles E. of Steyr.

WOLFSTEIN, a town of France, in the department of Mont Tonnerre; 43 miles W.N.W. of Manheim.

WOLHAUSEN IM MARKT, a town of Switzerland, in the canton of Lucerne; 7 miles W.S.W. of Lucerne.

WOLIN, or WOLYNIE, a town of Bohemia, in the circle of Prachatitz; 8 miles N.N.W. of Prachatitz. N. lat. $49^{\circ} 10'$. E. long. $13^{\circ} 45'$.

WOLIN, a town of Brandenburg, in the Middle Mark; 10 miles S.S.W. of Brandenburg.

WOLKART, a mountain of Carinthia; 8 miles N.E. of Millstatt.

WOLKENMARCK. See VOLKENMARK.

WOLKENSTEIN, a town of Saxony, in the circle of Erzgebirg, with a citadel, situated on a rock, near the Zschopa. About half a league from the town are some warm medicinal baths; 13 miles S.S.E. of Chemnitz. N. lat. $50^{\circ} 36'$. E. long. $12^{\circ} 59'$.—Also, a town of the county of Tyrol; 3 miles W. of Lientz.

WOLKOMYSK, a town of Lithuania, in the palatinate of Novogrodek; 40 miles W.S.W. of Novogrodek.

WOLLACOMB BAY, a bay of England, on the west coast of Devonshire, situated to the north of Barnstaple bay.

WOLLAPALLAM, a town of Hindoostan; 10 miles E. of Coimbatore.

WOLLASTON, WILLIAM, in *Biography*, an ethical writer, was born in 1659 at Cotton Clanford, in Staffordshire, and finished his education as a pensioner of Sidney college, Cambridge. In 1681 he commenced M.A. and entered into deacon's orders. His first settlement was as an assistant in the free school at Birmingham, to which a small lectureship was annexed; and about four years afterwards he was advanced from this laborious situation to the office of second master in the same school. In 1688 a relation died, whose decease put him in possession of a considerable landed estate, upon which he removed to London, and marrying a lady of considerable fortune, he resided in Charterhouse-square. Dismissing all thoughts of church preferment, he devoted himself to the retirement of private life and to a course of study, comprehending the learned languages, together with Hebrew and Arabic. The first publication which issued from the press was a poem on Ecclesiastes, which he would afterwards have suppressed, from a conviction that his talents were not adapted to poetry. In the progress of his life and literary pursuits, he was so much amused by composition, that he wrote many treatises on various subjects, both in Latin and English, which he committed to the flames. Of the well-known work which has perpetuated his name, and which is intitled "The Religion of Nature delineated," he printed a few copies to be distributed among his friends in 1722, but his declining health prevented his completing his original design. However, in 1723 he was prevailed upon to revise what he had printed for publication, and it accordingly appeared in 1724, in which year he died, at the age of 65, leaving a large family, and having lost his wife, to whom he was affectionately attached, about four years before. In his private character he is said to have exemplified the virtues which his work inculcated. The system which he developed, and which founded morality upon "truth," excited much attention, and his book, though not written in a popular manner, passed through seven editions to the year 1750. The last of these editions includes an appendix, consisting of a translation of the Latin notes by Dr. J. Clarke, dean of Salisbury, undertaken at the particular request of queen Caroline, who was a great admirer of the work. Dr. Warburton, in his strictures on Wollaston's theory in his *Divine Legation*, honours the author by ranking him as "one of our most celebrated writers," and compliments him with having "demonstrated with greater clearness than any before him the natural essential difference of things;" and though modern systems have in a considerable degree antiquated that of Mr. Wollaston, the author must always be regarded as a man of extensive learning and strong reasoning powers. *Biog. Brit.*

WOLLERSDORF, in *Geography*, a town of Germany, in the margravate of Anspach; 10 miles E. of Anspach.

WOLLERSTORFF, a town of Austria; 5 miles W.N.W. of Neutatt.

WOLLIN, a town of Brandenburg, in the Ucker Mark; 10 miles E.S.E. of Prenzlau.

WOLLIN, a town of Anterior Pomerania, on the east coast of the island so called, separated from the continent of Pomerania by the river Drenow, over which is a bridge, at which all travellers pay a toll. In this town are a seat and

prefecture. It stands on the site of the ancient city of Julin, which was formerly so famous for its commerce, though its origin is very obscure. The first mention of this city in history occurs immediately after the time of Charlemagne; and in the 11th century its prosperity was such, that Adam Von Bremen speaks of it as the largest city at that time in Europe. So early as the records of the 12th century, it is called Wolin. In the year 1127, it was set on fire by lightning, and being built of wood, was entirely consumed. The Pomeranian bishopric, which had been erected there but two years before, was translated upon that to Usedom, but on the rebuilding of the city, was restored to it. In the year 1170, being taken by Woldemar I. king of Denmark, and Jaromar I. prince of Rugen, it was sacked and burned; and after retrieving this calamity was, in the year 1175, again set on fire, and utterly destroyed, inasmuch that in the very same year the duke of Pomerania removed the bishopric to Cammin. It was indeed rebuilt again, but never recovered its former greatness; 25 miles N. of Old Stettin. N. lat. 53° 48'. E. long. 14° 35'.

WOLLIN, an island formed at the mouth of the Oder, between the Baltic and the Frische Haff; the form of an irregular triangle, about thirty miles in circumference. This island is frequently in danger of being overflowed, and the sea-winds hurt it considerably, by throwing up drifts of sand. It produces excellent cattle, with plenty of game and fish; and one part of it, called the Pritter, is remarkable for the great quantity of eels taken there. Besides the town of Wollin, it contains several villages.

WOLLO, a town of Africa, on the Ivory Coast.

WOLLY. See **WOOLLI**.

WOLMIRSTADT, a town of Westphalia, in the duchy of Magdeburg. In the year 1642, this town was set on fire by the Imperial troops; 10 miles N. of Magdeburg. N. lat. 52° 18'. E. long. 11° 45'.

WOLMSDORF, or **WONSDORF**, a town of Prussia, in the province of Smalend; 24 miles S.E. of Königsberg.

WOLNITZ, a town of Saxony, in the principality of Eisenach; 2 miles S. of Jena.

WOLNZACH, a town of Bavaria; 6 miles N.E. of Pfaffenhofen.

WOLPA, a town of Lithuania, in the palatinate of Novogrodek; 54 miles W. of Novogrodek.

WOLPAFFING, a town of Austria; 4 miles S.S.E. of Weikerdorf.

WOLSDORFF, a town of the duchy of Bremen; 5 miles S. of Carlstadt.

WOLSEY, or **WULCEY**, THOMAS, cardinal, in *Biography*, was the son of a butcher at Ipswich, Suffolk, and born there in 1471. He finished his education at Magdalen college, Oxford, and was graduated B.A. at the age of 15. He was afterwards fellow of his college, and having taken the degree of M.A. became master of the school dependent upon that college, where he had under his tuition three sons of the marquis of Dorset, by whom he was presented to the rectory of Lymington in Somersetshire, into which he was inducted in 1500. His advancement was rapid, first as domestic chaplain to the archbishop of Canterbury, and afterwards as chaplain to the household of Henry VII. His manners were insinuating, and he became the confidante of the king, who communicated to him his projected marriage with the daughter of the emperor Maximilian. Wolsey met the emperor at Bruges, and executed his commission so much to the king's satisfaction, that he nominated him to the deanery of Lincoln. After the death of Henry VII. he was recommended by Fox, bishop of Winchester, to Henry VIII., whose

favour

favour and confidence he conciliated by his blending amusement with business, inasmuch that he supplanted the ministers of the late king, and became himself uncontrolled minister. His preferments, civil and ecclesiastical, very speedily succeeded one another, and even profusely accumulated. He was introduced into the privy-council in 1510, made reporter of the star-chamber, registrar, and afterwards chancellor of the garter; and advanced to the sees of Tournay and Lincoln in 1513, to that of York in 1514, and to the dignity of cardinal in 1515. Thus promoted, his pride and love of pomp kept pace with his elevation of rank. In his train of servants, 800 in number, were many knights and gentlemen; and the sons of noblemen acted occasionally as his domestic menials. His equipage and furniture were of the most costly kind; but it is needless to multiply particulars. The most pardonable, not to say laudable, display of his magnificence was exhibited in his patronage of literary men and promotion of literature, both by the exercise of private bounty and the establishment of public institutions. The pope nominated him legate à latere, by which office he acquired legal pre-eminence over the archbishop of Canterbury; and in December 1515, he was elevated to the office of high-chancellor. By the equity of his decisions in the exercise of this office he gained great credit; but his conduct as legate à latere was so arbitrary and oppressive, as to produce complaints against him to the king. Charles V. and Frederic I. purchased his interest with Henry VIII. by pensions, and he was also retained in the same way by the pope. Charles flattered him with hopes of the papal crown, and settled upon him the revenues of two bishoprics in Spain. Still insatiable in the pursuit of ecclesiastical preferments, he obtained the administration of the see of Bath and Wells, and the temporalities of the abbey of St. Alban's, to which were afterwards added successively the rich bishoprics of Durham and Winchester. His revenues, thus amounting nearly to that of the crown, were expended partly in the ostentation of pomp, and partly in laudable munificence. He founded several lectures at Oxford for liberal and useful studies, and at length erected in that university the celebrated college of Christchurch. He also established a collegiate school in his native town of Ipswich. The palace which he built at Hampton Court he presented, in 1528, to the king, and he further ingratiated himself with Henry by an arbitrary loan for the supply of his wants; but by these measures he became more and more odious to the nation. But his fall was approaching; and the first step to it was the divorce of queen Catharine. This was followed by the marriage of Henry with Ann Boleyn, whose influence was employed in effecting his downfall. At length the king, not without hesitation and reluctance, employed the dukes of Norfolk and Suffolk, in 1529, to require him to surrender the great seal, and to quit York-place, a palace which he had built in London, and which afterwards became a royal residence under the name of Whitehall. His furniture and plate were seized for the king's use, and he was ordered to retire to Esher, a palace which belonged to him as bishop of Winchester. These measures overwhelmed the favourite, destitute of any inward resources of magnanimity; and when he received a slight token of the king's favour in this state of mental depression, he was transported with joy, dismounted on meeting the messenger, and fell upon his knees in the dirt to receive the expression of his master's kindness. Henry, however, was capricious and inconstant; a cloud overspread this gleam, and Wolsey was ordered to be indicted in the star-chamber, and abandoned by his sovereign to the rigour of parliament. An accusation, consisting of 44 articles, was

exhibited against him by the house of lords; and in the commons, he was so ably defended by Thomas Cromwell, who had been raised by the cardinal from a low condition to a high station, that his enemies were defeated. They thus changed their plan, and indicted him upon the statute of provisors, which prohibited his procuring bulls from Rome, and which he had violated by obtaining the legantine power; and this was made the ground of a sentence, putting him out of the king's protection, forfeiting all his lands and goods, and declaring him liable to imprisonment. When these measures had induced him to resign to the king York-place with all its furniture, he obtained a full pardon for all his past offences, and the restoration of the revenues of his archbishopric, with part of his goods. But fresh tokens of royal displeasure awaited him. The earl of Northumberland was ordered to arrest him for high treason, and to conduct him to London for trial. In his way from York to London, he was seized with a disorder which obliged him to stop at Leicester, where he was hospitably received in the abbey. His disorder in a few days terminated his life, in the 60th year of his age. Shortly before he expired he closed a conversation with the constable of the Tower, which related to the king, with this exclamation, "Had but I served God as diligently as I have served the king, he would not have given me over in my grey hairs!" Thus he sunk to the grave as a victim to tyranny, but to a tyranny which he had himself formed; exhibiting an instructive example to all future ministers of the insecure possession of power and wealth acquired by extortion and oppression, and of the folly of placing confidence in princes embracing arbitrary and despotic measures, and governed by caprice and personal ambition. Biog. Brit.

The magnificence of the cardinal's chapel-establishment, as described by Cavendish, his contemporary and domestic, seems far to have surpassed that of the Roman pontiff himself.

"First, he had there a deane, a great divine, and a man of excellent learning; a sub-dean, a repeatour of the quire, a gospeller and epittollor; of singing priests, ten, a master of the children. The seculars of the chapell, being singing-men, twelve; singing-children, ten, with one servant to waite upon them. In the vestry, a yeoman and two grooms; over and besides other retainers that came thither at principal feasts. And for the furniture of his chapell, it passeth my weak capacity to declare the number of the costly ornaments and rich jewels that were occupied in the same. For I have seen in procession about the hall forty-four rich copes, besides the rich candlesticks, and other necessary ornaments to the furniture of the same."

The earl of Northumberland, whose passion for Ann Boleyn is supposed to have occasioned his disgrace at court, seems to have been treated with great insolence and indignity by the cardinal, who, by an extraordinary extension of power, demanded his choral books for the use of his own chapel. Letters concerning this requisition are still preserved in the family, in which the earl says, "I do perceayff my lorde cardinall's pleasour ys to have such boks as was in the chapell of my lat lorde and ffayther (vos soll Jhu pardon.) To the accomplishment of which, at your desyer, I am conformable, notwithstandinge I trust to be able ons to set up a chapell off myne owne.—I shall with all sped send up the boks unto my lord's grace, as to say iiij Antiffonars (Antiphoners), such as I think wher not seen a gret wyll—v Gralls (Graduals)—an Ordcorly (Ordinal)—a Manuall—viij Proffessionars (Processionals)." Northumberland Household Book.

WOLSINGHAM, in *Geography*, an irregular town in

the county of Durham, England, is pleasantly situated in the vale of the Wear, on a point of land formed by the confluence of that river and the Wescrow. The church is situated at the north side of the town on rising ground, but possesses nothing worthy of remark. Near it are some remains of a considerable building, inclosed with a deep moat, supposed by some writers to have been part of a monastery, which was founded by Henry de Pudsey; but Hutchinon, in his History of Durham, refers them to the ancient manor-house of the bishop's, which is mentioned in Hatfield's Survey. The inhabitants of this parish, according to the returns of 1811, are 1983, the houses 399. The views down the Wear from the hill above Wolvingham include a very extensive and beautifully diversified country. Between this town and Stanhope, the commencement of the lead district is every where intimated by large parcels of lead lying near the sides of the road, and from the blue unwholesome vapours arising from the smelting mills in Bollihope. On Bollihope common, in 1749, was found a Roman altar with an inscription. This town is 6 miles S.E. by S. from Stanhope, and 259 N.N.W. from London. Here is a market held on Tuesday, and a fair on the 18th of May. The petty sessions are holden here. The parish, which is large, consists of Bradley, Hilton-park, Thornley, Wolvingham town quarter, East side quarter, Park quarter, and South side quarter.—Beauties of England, Durham, vol. iv.; by J. Britton and E. W. Brayley.

WOLTA, a town of Bohemia, in the circle of Konigin-gratz; 2 miles N. of Trautenau.

WOLTERN, a town of Germany, in the county of Verden; 30 miles E. of Rotenburg.

WOLTERS DORF, a town of Saxony; 2 miles S.W. of Zahna.

WOLTIN, a town of Hinder Pomerania; 12 miles S.W. of Stargard.

WOLTZTORFF, a town of Austria; 2 miles N.N.W. of Weikerstorf.

WOLVERENE. See GLUTTON.

WOLVERHAMPTON, formerly HAMPTON, in *Geography*, an important market-town in the hundred of N. Seifdon, and county of Stafford, England, is particularly noted for its extensive manufactures of locks, keys, and other articles of ironmongery. It is situated on a rising ground 16 miles S. from Stafford, 14 S.W. from Lichfield, 13 N.W. from Birmingham, and 130 in the same direction from London. Wolverhampton is of ancient date, for as early as 996 a monastery was founded there by Wulfruna, from whom the town received the first member of its name. The institution, consisting of a dean and secular canons, was about the year 1200 transferred by the dean, Peter of Blois, to the archbishop of Canterbury, to convert it into an abbey for Cistercian monks; but this design seems not to have been executed, for the seculars appear to have been not long after in possession of the establishment. The church, which was considered as one of the king's free chapels, was by Edward IV. annexed to the deanery of Windfor; but in the seventh year of Edward VI. a grant of the college of Wolverhampton and seven prebends was made to John, duke of Northumberland. Coming again to the crown by his attainer, queen Mary reinstated the dean and prebendaries, and endowed them with all the lands, &c. which formerly belonged to the institution, then valued at the yearly rent of 113*l.* 13*s.* On a question arising concerning those possessions, the grants of Mary were confirmed by James I., who appointed the celebrated Marc-Antonio de Dominis, who had been archbishop of Spalatro in Dalmatia, to be dean of Windfor, and dean and first prebendary of Wolverhampton:

those deaneries continue to be united, but the colleges are separate.

Wolverhampton is well built, and considered as salubrious, notwithstanding it is in the vicinity of many coal-mines. The parish is of great extent, being nearly 30 miles in circuit, and comprehends, besides the town, seventeen considerable townships, or villages, among which are, Bilston, Featherstone, Hatherton, Hilton, and Kinvafton. According to the returns to parliament in 1811, the houses in the whole parish were 2936, and the inhabitants 14,836. A market is held on Wednesday, and a fair on the 10th of July. The skill and ingenuity of the lock-smiths of the town and the environs, (for many of the farmers themselves are concerned in the business,) and the trade carried on in these and similar articles of iron manufacture, are unparalleled in England: the trade is particularly promoted by the Staffordshire and Worcestershire grand trunk, and the Birmingham canals, which unite about a mile to the N. of the town. The town is governed by two constables, and in it are held the petty sessions for the N. and S. divisions of Seifdon hundred.

The collegiate church of St. Peter stands on an elevation on the E. side of the town, and consists of a lofty nave, with side-aisles and a chancel. From the centre of the building, which is of stone, rises a tower. The nave is separated from the aisles by five pointed arches, supported by octagonal pillars. Against one of the S. pillars is erected a very curious stone pulpit. The font, which is octagonal, and covered with sculptured figures, &c. appears to be very ancient. In the great chancel is a full-length statue, in brass, of the celebrated admiral sir Richard Leveson, who had a command against the Spanish armada, under sir Francis Drake. In the church-yard stands a round column twenty feet high, profusely but rudely carved in divisions, and the whole surmounted by a plain capital. It is evidently ancient, and may have supported a cross, or the figure of the patron-saint. The situation of Wulfruna's monastery is unknown; but in the S.W. corner of the burying-ground is a large room supported by groins, the walls of which are three yards in thickness. Besides St. Peter's, Wolverhampton possesses another church, dedicated to St. John, which was erected by subscription, and consecrated in 1761. Dissenters of various denominations abound in the parish of Wolverhampton, and comprehend more than one half of the inhabitants: chapels for their accommodation are consequently numerous. A free-school was founded here by sir Stephen Jennings of Wolverhampton, who was lord-mayor of London in 1668; besides which, charity-schools are maintained for children of both sexes. Bilston, a large and populous village two miles S.E. from the town, is within the parish of Wolverhampton; but as to all parochial concerns it is a separate township. In 1811 Bilston contained 1862 houses, and the inhabitants amounted to 9646. Here is a parochial chapel, which is a neat modern structure: the living is a perpetual curacy within the exempt jurisdiction of the dean of Wolverhampton; but the nomination and presentation of the incumbent are vested in the inhabitants at large. Bilston contains likewise two dissenting meetings, and an excellent charity-school. The business of Bilston consists chiefly of japanned and enamelled goods. The vicinity abounds in coal, iron-stone, with numerous smelting-furnaces and forges, &c. in which the operations are performed by steam-engines. Bilston furnishes also a peculiar kind of sand of great use in casting metals. At Bradley, near Bilston, the subterraneous coal has been burning for several years past, and every attempt to extinguish it has hitherto proved fruitless, by which several

val acres of land have been rendered unproductive. The fire proceeds from a burning stratum of coal about four feet thick, and eight or ten yards deep, to which the air has free access; as the main bed of coal has been dug out from under it. In collecting the calcined substances for repairing the roads, sulphur and alum are frequently found. Tatenhill, a small village on a steep eminence two miles N. from Wolverhampton, was the scene of a severe battle between Edward the Elder and the Danes, in the beginning of the 10th century. In this place was founded, before the Norman Conquest, a college with a dean and five prebends, which subsisted till the general dissolution by Henry VIII. The present church, or chapel, is apparently a part of that establishment. At Wrottesley, a village in the parish of Wolverhampton, extensive ancient remains have been discovered, supposed, by Dr. Plott, in his History of Staffordshire, to be vestiges of the old Theotenhall of the Danes: but later antiquaries imagine these remains to belong to the Uriconium of Roman Britain. The parish of Wolverhampton, although varied with eminences, is in general level, and ornamented with a number of agreeable hamlets and country-seats.—History and Antiquities of Staffordshire, by the Rev. Stebbing Shaw, fol. Lond. 1798. Beauties of England and Wales, Staffordshire, 8vo. Lond. 1814.

WOLVES-TEETH, of a horse, are overgrown grinders, the points of which, being higher than the rest, prick the creature's tongue and gums in feeding, so as to hinder chewing of the meat.

They are seldom met with but in young horses; but if they be not daily worn by chewing, they will grow up even to pierce the roof of the mouth.

There are usually two of these wolves-teeth, which are small, and grow in the upper-jaw, next to the great grinding-teeth: these are so tender and painful, that the horse cannot chew his meat, but is forced to let a great part of it fall out of his mouth, or swallow it half chewed.

The remedy, in this case, is to tie up the horse's head to some part of the rafter, and open his mouth with a cord; then with an instrument like a carpenter's gauge, and a mallet, the teeth that are thus troublesome are to be knocked out, and the holes filled up with salt.

If the upper-jaw teeth hang over those of the under-jaw, and by that means cut the mouth, the same instrument is to be used, and the teeth are to be pared shorter by little and little. When they are sufficiently pared down, they must be filed smooth, and the mouth washed with vinegar and salt, and the whole complaint will be thus removed.

WOLVES, *Rout of*. See **ROUT**.

WOLVES ISLANDS, in *Geography*, a cluster of small islands near the E. coast of Maine. N. lat. 45° 4'. W. long. 66° 50'.

WOLVEY, a village of England, in the county of Warwick. It was at this place that Edward IV. was surprised and taken prisoner by Richard Nevil, earl of Warwick; 10 miles N.E. of Coventry.

WOLZ. See **WELS**.

WOMAN, **FEMINA**, *Mulier*, the female of man.

A woman, in England, as soon as she is married, with all her moveables, is wholly in *potestate viri*, or at the will and disposal of her husband.

There are divers considerable things relating to women in the laws of England, which see under **WIFE**.

St. Augustine calls women the *devout sex*; at least, this is the common opinion; though others rather think, that in the prayer usually attributed to that father, and still rehearsed in the Romish church to the Holy Virgin, the words

“intercede pro devoto fœmineo sexu,” are to be understood of women devoted or consecrated to God in religious houses; which had been sufficiently expressed by the words, “ora pro populo, interveni pro clero.”

It is a popular tradition among the Mahometans, which obtains to this day, that women shall not enter paradise.

An anonymous author, about the close of the sixteenth century, published a little Latin dissertation, to prove that women are not men; that is, are not reasonable creatures: “Dissertatio perjucunda, qua anonymus probare nititur mulieres homines non esse.” He also endeavours to prove, what naturally follows from this principle, *viz.* that women shall not be saved, that there is no future life or happiness for them. His proofs are all taken from Scripture, or founded on Scripture. Though, after all, his aim is not so much to degrade women to the condition of brutes, as to ridicule the principle or method of many Protestants, who, in points of controversy, admit of no proofs or considerations but what are taken from Scripture alone. This appears from the conclusion of the work. “Probavi, opinor, invictissimis SS. literarum testimoniis, mulierem non esse hominem, nec eam salvari: quod si non effeci, ostendi tamen universo mundo, quomodo hujus temporis hæretici, et præsertim Anabaptistæ, sacram soleant explicare Scripturam, et quo utantur methodo ad stabilienda sua execranda dogmata.”

Yet Simon Gediccus, a Lutheran divine, wrote a serious confutation of this piece in 1595, wherein the women are restored to the expectation of heaven, on their good behaviour.

The ancient Marcionites allowed their women to baptize; as we are assured by St. Epiphanius, Hær. 42. cap. 4. the Montanists admitted women to the priesthood, and even the episcopate, Epiph. Hær. 49. cap. 2. The modern Quakers also permit their women to preach and prophecy, on an equal footing with the men.

It is a point much controverted, how far learning and study become the sex? Erasmus handles the question at large in one of his letters to Budæus. Lud. Vives, in his *Institutio Fœminæ Christianæ*, has a chapter expressly on the same subject. Madam Schurman, a German lady, has gone beyond them both, in a treatise on this problem, “Num fœminæ Christianæ conveniat studium literarum?”

Several of the women remarkable for learning have been also distinguished for their want of conduct. The reason, no doubt, lay in this; that their first studies lying in books of gallantry and intrigue, the imagination was early turned that way, and the memory filled with a sort of ideas, which a favourable disposition, and age, adopted too easily, and improved too fast. It is not that study in itself has any natural tendency to produce such effects; rather the contrary: the close abstracted researches of metaphysics, logics, mathematics, physics, criticism, &c. no doubt would be the surest means to secure and establish the virtue of continency in a woman.

For an account of women hired to weep at funerals by the Romans, see **PRÆFICÆ**.

Women were allowed to sing, in 1772, in the collegiate church of St. Gudula, at Brussels. It was in the performance of high mass on a Sunday, when a considerable number of voices and instruments were assembled in the choir; and we were glad to find among the former two or three women, who though they were not fine singers, yet their being employed, proved that female voices might have admission in the church, without giving offence or scandal to piety, or even bigotry. If the practice were to become general, of admitting women to sing the soprano part in the cathedrals,

it would, in Italy, be a service to mankind, and in the rest of Europe render church music infinitely more pleasing and perfect; in general, the want of treble voices, at least of such as have had sufficient time to be polished, and rendered steady, destroys the effects of the best compositions, in which, if the principal melody be feeble, nothing but the subordinate parts, meant only as attendants, and to enrich the harmony of the whole, can be heard.

WOMEN, *Appeals of*. See APPEAL.

WOMEN, *Jury of*. See JURY of MATRONS.

WOMEN, *Stealing, or Seduction of*, is punishable by the statute 4 & 5 Ph. & Mar. cap. 8. which enacts, that if any person above the age of fourteen unlawfully shall convey or take away any woman child unmarried, (which is held to extend to bastards as well as to legitimate children,) within the age of sixteen years, from the possession and against the will of the father, mother, guardians, or governors, he shall be imprisoned two years, or fined at the discretion of the justices: and if he deflowers such maid or woman child, or, without the consent of parents, contracts matrimony with her, he shall be imprisoned five years, or fined at the discretion of the justices, and she shall forfeit her lands to her next of kin, during the life of her said husband. But this latter part of the act is now rendered almost useless, by provisions of a very different kind, which make the marriage totally void, in the statute 26 Geo. II. cap. 33. See MARRIAGE. See also FORCIBLE *Abduction, RAPE, and RAVISHMENT.*

WOMB, MATRIX, or *Uterus*, in *Anatomy*, that part of the female of any kind, wherein the fœtus is conceived and nourished till the time of its delivery.

The ancient Greeks called the *matrix*, $\mu\alpha\tau\epsilon\kappa\eta$, from $\mu\alpha\tau\epsilon\kappa\eta$, *mother*: whence disorders of the womb are still frequently called *fits of the mother*. They also call it $\upsilon\tau\epsilon\rho\eta$, as being the lair of the entrails, by its situation. Sometimes they also call it $\phi\upsilon\upsilon\sigma\iota\varsigma$, or *natura*; and *vulva*, from *volvo*, to fold, or *envelope*, or from *valvæ*, doors. See UTERUS.

WOMB, *Dropsy of the*. See DROPSY.

WOMB, *Falling down of the*. See PROCIDENTIA Uteri.

WOMB, *Inflammation of the*. See INFLAMMATION.

WOMB, *Suffocation of the*. See SUFFOCATION.

WOMB, *Ulcers of the*. See ULCERS.

WOMB, in *Geography*, a town of Sweden, in the province of Skonen; 12 miles E. of Lund.

WOMBACH, a town of Germany, in the county of Rieneck; 3 miles S. of Lohr.

WOMBAT, in *Zoology*, an animal of which Mr. E. Home has given an anatomical description in the 2d part of the 98th volume of the Philosophical Transactions. It was brought from the islands in Bassa's straits, and lived with him in a domesticated state for two years. Whenever it had an opportunity, it burrowed in the ground, and covered itself in the earth with surprising quickness. It was quiet in the day, but in constant motion during the night; very sensible of cold; ate all kinds of vegetables; was particularly fond of new hay, which it ate stalk by stalk. It appeared attached to those to whom it was accustomed, and who were kind to it. It allowed children to pull and carry it about, and when it bit them it was not in anger or with violence. It appeared to have arrived at its full growth, weighed about twenty pounds, and was about two feet two inches long. Another animal called the 'Koala,' is a species of the wombat, partaking of its peculiarities. It inhabits the forests of New Holland, about fifty or sixty miles S.W. of Port Jackson, whither it was brought in August 1803, and is called by the natives the 'koala wombat.' It is commonly about two feet long and one high; in the girth about

a foot and a half: it is covered with fine soft fur, lead-coloured on the back and white on the belly: the ears are short, erect, and pointed; the eyes generally ruminating, sometimes fiery and menacing: it bears no small resemblance to the bear in the fore-part of its body: it has no tail; and its customary posture is sitting. The New Hollanders eat the flesh of this animal; and are very dextrous in the pursuit of it, climbing with wonderful rapidity the loftiest gum-trees in search of it. The koala feeds upon the tender shoots of these trees; and during the day rests on the tops of them, either feeding at ease, or sleeping. In the night it descends, prowls about in search of some particular roots, creeping rather than walking; and when incensed or hungry, it utters a long shrill yell, and assumes a fierce and menacing look. These animals are found in pairs, and the young is carried by the mother on its shoulders. It soon forms an attachment to the person who feeds it.

The external form of the wombat has been described by M. Geoffroy, in the 2d volume of the "Annales du Muséum National de France;" and several parts of its internal structure have been taken notice of by M. Cuvier, in his "Leçons d'Anatomie Comparée." The mechanism of the bones and muscles of the hind legs differs in many respects from that of all other animals, except the koala. This has been minutely examined and described by Mr. Brodie, at the desire of Mr. Home; and it appears that there is nothing similar to it in the hind legs of the mole, or other burrowing animals. The internal structure of the wombat resembles that of the beaver; but it is so different from that of the kangaroo, and all the other animals of the opossum tribe, that it forms a very extraordinary peculiarity. The male and female organs of generation have been described; the former by M. Cuvier, and the latter by Mr. Bell in New South Wales. The male and female organs of the wombat and koala are similar to those of the opossum; and hence it is concluded, that these animals form the intermediate link between the opossum and kangaroo. See DIDELPHIS.

WOMBINELLORE, in *Geography*, a town of Hindoostan, in Baramaul. It was taken by the British, under general Meadows; 100 miles S.E. of Seringapatam. N. lat. 11° 43'. E. long. 78° 15'.

WOMBORN, a township of England, in Staffordshire; 3 miles S.W. of Wolverhampton.

WOMELSDORF, a town of Pennsylvania; 15 miles W. of Reading.

WONDA, a town of Africa, in Manding; 30 miles N.E. of Kamalia. See MANDING.

WONDA, a river of Manding, which, at Fonilla, a small walled village on its banks, is called Ba Woolima (red river); and towards its source it has the name of Ba Qui (white river); the middle part of its course being called Wonda.

WONDER. See MIRACLE.

The seven wonders of the world, as they are popularly called, were, the Egyptian pyramids; the mausoleum erected by Artemisia; the temple of Diana at Ephesus; the walls and hanging gardens of the city of Babylon; the colossus, or brazen image of the sun, at Rhodes; the statue of Jupiter Olympius; and the pharos, or watch-tower, of Ptolemy Philadelphus: instead of the latter, some reckon the royal palace of Cyrus, built by Menon, the stones of which were cemented with gold. See PYRAMID.

WONDERFUL WATER. See WATER.

WONDRA, or WONDREE, in *Geography*, a river which rises in Bavaria, and runs into the Egra, near Königberg, in Bohemia.

WONDRZEGOW, a town of Bohemia, in the circle of Kaurzim; 10 miles W.S.W. of Kaurzim.

WONSDORF,

WONSDORF, a town of Prussia, in Natangen ; 25 miles S.E. of Königsberg.

WONSIEDEL. See WUNSIEDEL.

WONTAMITTA, a town of Hindoostan, in Mysore ; 45 miles E. of Chinna Balabarum.

WOO-CHIN, a town of China, in the province of Kiangsi, near the lake Poyang, which is a place of considerable importance, as the great mart for exchanging commodities between the north and south of China. The warehouses are spacious and well filled, dwelling-houses large and substantial, temples richly decorated, and the shops filled with articles of all kinds, including no inconsiderable proportion of European goods. Here are several small bronze vessels of ancient and modern workmanship, not unlike the Grecian and Etruscan. Near it is a temple dedicated to Wang-shinchoo, the god of longevity, surpassing most others in riches of carved-work and gilding.

WOOD, WILLIAM, F.L.S., in *Biography*, a Protestant dissenting minister of distinguished reputation for general literature and science, character, and usefulness, was born at Collingtree, a village near Northampton, on May 29, O.S. 1745. His father, though occupying a humble station, was a person of approved integrity and piety, in connection with the Christian society at Northampton, under the personal care of the justly-celebrated Dr. Doddridge, and paid particular attention to the religious instruction and moral conduct of his children. Mr. Wood, at an early age, manifested promising talents, and having finished his school-education under the late Dr. Addington of Market-Harborough, was introduced, at the age of 16, with a view to the ministry, among Protestant dissenters, which was the object of his choice, to a dissenting academy in London, conducted at the time of his admission by Dr. David Jennings and Mr. (afterwards Dr.) Morton Savage, and before the close of his studies by Mr. Savage, Mr. A. Kippis, and Mr. A. Rees. The writer of this sketch can bear personal testimony to his exemplary conduct during the period of his continuance at the academy, and to the diligence and success with which he prosecuted the various branches of literature and science to which his attention was directed. Few persons ever left a public seminary with superior qualifications for the exercise of the profession to which he was devoted, and performed the duties of it, in the progress of a long and honourable life, more acceptably and more usefully. It was then the custom, admitting of few exceptions, to ordain ministers when they were elected by particular congregations, and introduced into the full discharge of the pastoral office ; and some, we understand, of the wisest and best of the Non-conformist ministers have lamented the too general discontinuance of this decorous practice, against which it is thought by many that no sufficient objection has been alleged. Ordination among Protestant dissenters is a public service, usually conducted at the place where the minister, who is ordained or set apart, is about to be settled ; and consists of a sermon addressed to the people, a charge delivered to the person ordained, and prayers for a divine blessing on his future labours, and for the edification and prosperity of the Christian society with which he is connected. It has been sometimes accompanied with a confession of faith on the part of the person who is thus set apart ; but this part of the service, having been misunderstood, is frequently omitted, though in cases which allow of unrestricted liberty, and in which the confession neither descends into a variety of minute particulars, nor contains any pledges that embarrass or restrain future free inquiry, it is thought to be unexceptionable. Ordination, however, among the persons to whom we now refer, is not conceived to impart any new qualifications or powers

which the person ordained did not possess previously to this service, or to constitute him either a minister in general, or the pastor of any particular church. But to return from this digression : Mr. Wood was publicly ordained, and the occasion afforded an opportunity for many ministers of acknowledged reputation among dissenters to bear their united testimony to his talents and character. He commenced his public services at Debenham in Suffolk, on the 6th of July 1766, with a sermon peculiarly appropriate to the occasion, from Luke, ix. 26., and he spent the remaining part of this year, and a great part of the year 1767, in the vicinity of London, where he occasionally officiated to the satisfaction of those who attended, and gained the friendship of some of the most eminent of the dissenting ministers of that period. In September 1767, he settled at Stamford, in Lincolnshire ; and removed from thence to Ipswich in November 1770, where he remained till the close of the year 1772. In 1773, having nearly completed his 27th year, he was unanimously chosen to succeed Dr. Priestley at Mill-hill chapel, Leeds, and in that connection he continued till his death. About two years after his settlement with this congregation, he published a small volume consisting of twelve sermons on social life, which entitled the author, in the judgment of a contemporary critic, to the character of a useful and elegant preacher. In 1780 he formed a matrimonial connection with a daughter of Mr. George Oates, of Low-hall, near Leeds, which lasted twenty-six years, and contributed in a high degree to his domestic felicity. By this lady he had four children, of whom three survived their parents.

Ardently devoted to the studies that were more immediately or more remotely connected with his profession, and attached by affectionate gratitude as well as interest to the congregation in the service of which he was engaged, and which claimed his most assiduous and respectful attention, he commenced for the benefit of the young a course of lectures, in the year 1785. These were comprehensive and improving ; and though they were delivered once a fortnight, they lasted several years. Our limits will not allow us to avail ourselves of the detail, furnished by his excellent biographer, of the subjects which were discussed in this extensive course of useful instruction. It will be sufficient to observe, that they contributed no less to the information of those who attended them than to the reputation of the lecturer, as well as to the mutual respect and esteem which were thus cemented between Mr. Wood and his congregation. The public would probably have derived instruction from the perusal of them, if some circumstances had not occurred which rendered it necessary for Mr. Wood to devote a considerable part of his time and attention to subjects of a very different nature. Without abandoning the studies connected with his profession, he was led by the state of his health, and by some other considerations, to the pursuit of natural history, and particularly of English botany ; but whilst he was thus occupied, he rendered his investigations subservient to the great object of his life and ministry, the promotion of religion and virtue, as well as the personal satisfaction and future happiness of those with whom he was connected. His new pursuits were the means of introducing him to acquaintance and friendship with many eminent persons ; and more especially with Dr. (now Sir James) Smith, the justly celebrated president of the Linnæan Society. To Mr. Wood the good opinion and friendly regard of *one*, who commands the respect and esteem of all who know him, by mental accomplishments and moral qualities of the most excellent and engaging kind, must have afforded a satisfaction which, as we can testify from personal know-

ledge, he very highly appreciated. The good opinion of such a judge of merit, in the department of natural history, which now engaged his attention, must have encouraged his assiduity and perseverance. He was thus qualified for contributing several valuable articles to this Cyclopædia, in the reputation and success of which the editor is happy to say he felt and expressed a peculiar interest. His contributions comprehended the botanical articles that occur, with some few exceptions, from the beginning of the letter B to the end of C; and the editor, who most sincerely lamented his death as a pupil and a friend, as well as a coadjutor in this work, would have found it difficult to supply the loss, if the kindness and condescension of the Linnæus of our time, for so, it is hoped, we may be allowed to denominate him without offending his delicacy, had not relieved his anxiety, and amply compensated the injury which the botanical department of the Cyclopædia must have sustained.

Mr. Wood had attained, by his talents and cultivation of them, to so high a rank among his brethren in that part of the country where his lot was cast, that few public services occurred in which he was not expected to be active and conspicuous. Attached to liberty, civil and religious, from his youth, he had in his maturer years thoroughly acquainted himself with the genuine principles of the British constitution; and accordingly he took occasion on the centenary of the Revolution, in 1788, to express his conviction and feelings in two sermons, which were afterwards published. In the three following years he took an active part in the application of the dissenters to parliament for the repeal of the test and corporation acts. In 1794 he preached a funeral sermon, on occasion of the death of the Rev. W. Turner, of Wakefield; and in the following year he performed the same service in consequence of the decease of the Rev. Mr. Ralph, of Halifax: the sermons which he delivered in both cases were published. The short account of Leeds which was this year communicated to Dr. Aikin for his History of Manchester deserves to be noticed, as he took great pains in exactly ascertaining the number of its inhabitants. About this time he commenced a course of education, addressed to young females, with a view partly to his own emolument, but principally for the benefit of those who were disposed to avail themselves of his instruction; and indeed few persons could be found capable of conducting such a course with greater satisfaction and advantage to those who attended it. His lectures occupied three years, and comprehended history, geography, natural philosophy, grammar, the belles lettres, natural history, mental and moral philosophy, and the evidences of natural and revealed religion. His next publication was his sermon occasioned by the death of the Rev. Newcome Cappe, which contained a very appropriate and justly-merited eulogy of his late revered friend. It was dedicated to Mrs. Cappe, who claimed from her talents and character, as well as relation to the deceased, a tribute of respect; and annexed to it some brief memoirs of Mr. Cappe's life. In the year 1801, Mr. Wood published a liturgy, consisting of five forms, for the use of his congregation at Mill-hill chapel, and composed, for the most part, from the service of the established church, the Liverpool, Shrewsbury, and other liturgies before published by the dissenters, as well as from a similar service composed by the Rev. T. Simpson. Of this performance it will be sufficient to state, that it was executed with judgment and taste. On the restoration of peace in the year 1802, he published an animated discourse, which he delivered, in the course of his public services, on that occasion. About this time he exerted himself in establishing at York the academical institution, which had for some years subsisted at Manchester, and which was

likely to be discontinued in consequence of the resignation of the late Rev. G. Walker, the theological tutor.

Intending, as he advanced in life, and when he had finished the education of his daughter, to relinquish the anxiety and labour of tuition, he proposed to engage in some literary undertakings. Accordingly he was a contributor, in the department of natural history, to the Annual Review; but the work which occupied his chief attention, and which afforded him the greatest pleasure, was the Cyclopædia already mentioned.

As a preacher, the last of his publications was a sermon delivered at Birmingham, June 9, 1805, for the benefit of the Protestant dissenting charity-school, supported by the joint contributions of the two societies of the old and new meeting-houses. After his return from an excursion in the months of July and August 1806, he was attacked by a severe paroxysm of the gout, to which he had been long subject; and in a few days his disorder was so alarming, that his recovery was not expected. As an aggravation of his distress, the affectionate partner of his life was seized with a disorder, which terminated in her death. For some time his state was such, that it was prudent to conceal from him both the progress and termination of her disorder. The mournful event which he had apprehended was gradually disclosed to him; and he received the afflictive intelligence with a degree of composure and resignation, which evinced the efficacy of his religious principles, and the consolation derived in such circumstances from Christian hope. During a long illness, which interrupted his public labours, and which was attended with a considerable expence, the society with which he was connected had an opportunity of testifying, by substantial acts of kindness, the high sense they entertained of his meritorious services. Providence at length restored his health to such a degree, that he was able to resume his public labours; but they were of no long continuance. On Sunday the 27th of March 1808, he performed the usual services with an uncommon degree of animation. On the following day, however, having previously experienced symptoms of a flying gout, he was suddenly seized at dinner with a violent sickness, which continued for many hours. This was succeeded by an inflammation of the bowels, which soon terminated in a mortification. The consequence was a delirium; and on Friday, the 1st of April, he expired so quietly, that the friends who attended his bed were not apprized of the moment of his departure. Those who wish for further information concerning the natural talents and acquired endowments, the private character and public services of Mr. Wood, will be amply gratified by the perusal of the "Memoirs of his Life and Writings," and of the "Address and Sermon" delivered on occasion of his death, by his friend and neighbour the Rev. Charles Wellbeloved of York.

WOOD, ANTHONY, the *Oxford Antiquary*, was born at Oxford in 1632, and entered of Merton college in 1647. Having commenced M.A. and acquired a taste for studies pertaining to antiquity, he pursued with indefatigable diligence both at Oxford and in London researches, which furnished him with materials for his "History and Antiquities of the University of Oxford," a copy of which he sold to the university in 1669 for 100*l.* It was written in English, but afterwards translated into Latin, under the inspection of Dr. Fell; and the version was published from the Oxford press in 1674, under the title of "Historia et Antiquitates Universitatis Oxoniensis, duobus Voluminibus comprehensa," fol. The first part of this work includes the annals of the university, from its earliest period to the year 1648; and the second contains an account of all its particular foundations, endowments, officers, &c. The translation

is badly executed, and Wood, the original author, was destitute of those qualifications that would have rendered him a fit historian of a learned university. Another of Wood's works was his "Athenæ Oxonienses; or, an Account, in English, of almost all the Writers educated at Oxford, and many of those at the Sister University, from the year 1500." It was first published in 1691, 2 vols. fol., and soon after subjected him to a prosecution in the vice-chancellor's court for his account of lord Clarendon, and to various other attacks, occasioned by his partialities, and more especially by his strong bias in favour of popery. His style is vulgar, and his sentiments illiberal and unphilosophical; but his veracity entitles him to confidence. He died in 1695, and bequeathed his books and papers to the university of Oxford. A second edition of this work, corrected and enlarged from the author's MS., was published in 1721. Biog. Brit.

This curious and diligent antiquary, whose whole life was spent in the service of the dead, and whose labours, since his decease, have so much facilitated the inquiries, and gratified the curiosity of the living, tells us, in the Memoirs of his Life, written by himself, with monastic simplicity, that in 1651, "he began to exercise his natural and insatiable genie to musick. He exercised his hand on the violin, and having a good eare to take any tune at first hearing, he could quickly draw it out from the violin, but not with the same tuning of strings that others used. He wanted understanding, friends, and money, to pick him out a good master, otherwise he might have equalled in that instrument, and in finging, any person then in the university. He had some companions that were musical, but they wanted instruction as well as he."

The next year, being obliged to go into the country to try to get rid of an obstinate ague, by exercise and change of air, he tells, that "while he continued there he followed the plow on well-dayes, and sometimes plowed. He learned there to ring on the six bells, then newly put up: and having had from his most tender yeares an extraordinary ravishing delight in musick, he practised there, without the help of an instructor, to play on the violin. It was then that he tuned his strings in 4ths, and not in 5ths, according to the manner; and having a good eare, and being ready to sing any tune upon hearing it once or twice, he could play it also in a short time with the said way of tuning, which was never knowne before."

"After he had spent the summer in a lonish and retired condition, he returned to Oxon. And being advised by some persons, he entertained a master of musick to teach him the usual way of playing on the violin; that is, by having every string tuned five notes lower than the other going before. The master was Charles Griffith, one of the musitians belonging to the city of Oxon., whom he then thought to be a most excellent artist. But when Anthony Wood improved himself in that instrument, he found he was not so. He gave him 2s. 6d. entrance, and so quarterly. This person, after he had extreamly wondered how he could play so many tunes as he did by 4ths, without a director or guide, tuned his violin by 5ths, and gave him instructions how to proceed, leaving then a lesson with him to practice against his next coming."

In 1653, he found that "heraldry, musick, and painting, did so much crowd upon him, that he could not avoid them; and could never give a reason why he should delight in those studies, more than in others, so prevalent was nature, mixed with a generosity of mind, and a hatred of all that was servile, sneaking, or advantageous for lucre sake."

"Having by 1654 obtained a proficiency in musick, he

and his companions were not without silly frolicks, not now to be maintained."—What should these frolics be, but to disguise themselves in poor habits, and like country-fiddlers scrape for their livings. After strolling about to Farringdon fair, and other places, and gaining money, victuals, and drink for their trouble, in returning home they were overtaken by certain foldiers, who forced them to play in the open field, and then left them without giving them a penny. "Most of his companions would afterwards glory in this, but he was ashamed, and could never endure to hear of it."

By 1656, his record informs us, that "he had a genuine skill in musick, and frequented the weekly meetings of musitians in the house of William Ellis, organist of St. John's college, situated on that place whereon the theatre was built." Here he gives a list of the usual company that met and performed their parts on lutes and viols; among these eight were gentlemen. "The musick-masters were, William Ellis, bachelor of musick, and owner of the house, who always played his part either on the organ or virginal. Dr. John Wilson, the public professor, the best at the lute in all England: he sometimes played on the lute, but mostly presided (directed) the consort. — Curteys, a lutenist, lately ejected from some choir or cathedral church. Thomas Jackson, a base-violist. Edward Low, then organist of Christ church: he played only on the organ, so when he played on that instrument, Mr. Ellis would take up the counter-tenor viol, if any person were wanting to performe that part. Gervase Littleton *alias* Westcot, or Westcot *alias* Littleton, a violist. He was afterwards a singing-man of St. John's college. William Glexney, who had belonged to a choir before the war: he played well upon the base-viol, and sometimes sung his part. — Proctor, a young man, and a new comer. John Packer, one of the universitie musitians; but Mr. Low, a proud man, could not endure any common musitian to come to the meeting, much less to play among them. Of this kind I must rank John Haselwood, an apothecary, a starched formal clisterpipe, who usually played on the base-viol, and sometimes on the counter-tenor. He was very conceited of his skill (though he had but little of it), and therefore would be ever and anon ready to take up a viol before his betters; which being observed by all, they usually called him Handlewood. The rest were but beginners. Proctor died soon after this time. He had been bred up by Mr. John Jenkins, the mirror and wonder of his age for musick, was excellent for the lra-viol and division-viol, good at the treble-viol and violin, and all comprehended in a man of three or four-and-twenty yeares of age. He was much admired at the meetings, and exceedingly pitied by all the faculty for his loss."

At this time Anthony Wood tells us, that "what by musick, and rare books that he found in the public library, his life was a perfect *Elysium*."

"Anthony Wood was now advised to entertain one William James, a dancing-master, to instruct him on the violin, who by some was accounted excellent on that instrument, and the rather because, it was said, that he had obtained his knowledge in dancing and musick in France. He spent in all half a yeare with him, and gained some improvement; yet at length he found him not a compleat master of his facultie, as Griffith and Parker were not: and, to say the truth, there was no compleat master in Oxon. for that instrument, because it had not been hitherto used in consort among gentlemen, only by common musitians, who played but two parts. The gentlemen in private meetings, which Anthony Wood frequented, played three, four, and five parts with viols, as treble-viol, tenor, counter-tenor, and

base,

bass, with an organ, virginal, or harpsicon, joyned with them; and they esteemed a violia to be an instrument only belonging to a common fiddler, and could not endure that it should come among them, for feare of making their meetings to be vaine and fiddling. But before the restoration of king Charles II., and especially after, viols began to be out of fashion, and only violins used, as treble violin, tenor, and base violin; and the king, according to the French mode, would have twenty-four violins playing before him, while he was at meales, as being more airie and brisk than viols."

"In the latter end of the yeare 1657, Davis Mell, the most eminent violinist of London, and clock-maker, being in Oxon., Peter Pitt, William Bull, Kenelm Digby, and others of All Soules, as also Anthony Wood, did give a very handsome entertainment in the tavern called the 'Salutation.' The company did look on Mr. Mell to have a prodigious hand on the violin, and they thought that no person, as all in London did, could goe beyond him."

By connecting the scattered fragments of this zealous Dilettante's life, which concern music, we shall be able to form an idea of the state of the art, not only at Oxford, but in every other part of the kingdom where it was more secretly practised during the latter part of the Usurpation.

Under the year 1658, Anthony Wood tells us, that "he entertained two eminent musicians of London, named John Gamble and Thomas Pratt, after they had entertained him with most excellent musick at the meeting-house of William Ellis. Gamble had obtained a great name among the people of Oxon. for his book of 'Ayres and Dialoges to be sung to the Theorbo; or Base-viol.' The other for several compositions, which they played in their consorts."

He then gives an account of the arrival of Baltzar, a wonderful performer on the violin, from Lubec, arriving at Oxford, and destroying, by his great superiority of hand, all the little vanities, not only of the best fiddle-players of the university, but of others from London, who had long enjoyed the reputation of great performers. See BALTZAR.

Anthony Wood pursues his musical records, and tells us, that "all the time he could spare from his beloved studies of English history, antiquities, heraldry, and genealogies, he spent in the most delightful facultie of musick, instrumental or vocal; and if he had missed the weekly meetings in the house of William Ellis, he could not well enjoy himself all the week after. Of all or most of the company, when he frequented that meeting, the names are set downe under the year 1656. As for those that came in after, and were now performers, and with whom Anthony Wood frequently played, were these: Charles Perot, M.A. fellow of Oriell college, a well-bred gentleman, and a person of a sweet nature; Christopher Harrison, M.A. fellow of Queen's college, a maggot-headed person, and humourous; Kenelm Digby, fellow of All Soule's college, he was afterwards Dr. of L., he was a violinist, and the two former violists; William Bull, M.A. for the viol and violin; John Vincent, M.A. a violist; Sylvanus Taylor, fellow of All Soule's college, violist and songster, his elder brother, captain Silas Taylor, was a composer of musick, played and sung his parts; Henry Langley, M.A. a violist and songster; Samuel Woodford, M.A. a violist; Francis Parry, M.A. a violist and songster; Christopher Coward, and Henry Bridgman, both masters of arts; Nathan Crew, M.A. a violinist and violist, but alwaies played out of tune, as having no good eare, he was afterwards bishop of Durham; Matthew Hutton, M.A. an excellent violist; Thomas Ken of New college, afterwards bishop of Bath and Wells, he would be sometimes among them and sing his part; Chris-

topher Jefferyes, a junior student of Christ church, excellent at the organ and virginals, or harpsicon, having been trained up to those instruments by his father George Jefferyes, organist to king Charles I. at Oxon.; Richard Rhodes, another junior student of Christ church, a confident Westmonasterian, a violinist to hold between his knees."

"These did frequent the weekly meetings, and by the help of publick masters of musick, who were mixed with them, they were much improved. Narcissus Marsh would come sometimes among them, but seldom played, because he had a weekly meeting in his chamber, where masters of musick would come, and some of the company before-mentioned. When he became principal of St. Alban's hall, he translated the meeting thither, and there it continued, when that meeting at Mr. Ellis's house was given over, and so it continued till he went over to Ireland, where he became afterwards archbishop of Tuam.

"After his majesty's restoration, when the masters of musick were restored to their several places that they before had lost, or gotten other preferment, the weekly meetings at Mr. Ellis's house began to decay, because they were only held up by scholars who wanted directors and instructors. So that these meetings were not continued above two or three yeares, and I think they did not go beyond 1662."

Our Oxford annalist terminates his account of the musical transactions of that university, during the interregnum, by the following anecdote.

"In October 1659, James Quin, M.A. and one of the senior students of Christ church, a Middlesex man borne, but son of Walter Quin, of Dublin, died in a crazed condition. Anthony Wood had some acquaintance with him, and hath several times heard him sing with great admiration. His voice was a bass, and he had a great command of it. 'Twas very strong and exceeding trouling, but he wanted skill, and could scarce sing in comfort. He had been turned out of his student's place by the visitors; but being well acquainted with some great men of those times, that loved musick, they introduced him into the company of Oliver Cromwell, the protector, who loved a good voice and instrumental musick well. He heard him sing with very great delight, liquored him with sack, and in conclusion said, 'Mr. Quin, you have done very well, what shall I do for you?' To which Quin made answer with great compliments, of which he had command with a great grace, that 'your highness would be pleased to restore him to his student's place;' which he did accordingly, and so kept it to his dying day."

If this minute and indiscriminate antiquary and biographer is sometimes thought to want taste and selection sufficient to give his records due weight, it must be ascribed to the constant habit he was in of journalizing, collecting anecdotes, and making memorandums of every person, transaction, and circumstance, that arrived at his knowledge, in the uncouth and antiquated language of his early youth. For this dialect being inelegant and vulgar, even when he learned it, renders his writings frequently ridiculous, though they contain such information as can be nowhere else obtained. But the few opportunities he had of knowing the gradual changes in our colloquial dialect, by conversing with men of the world, or even the language of elegant books by his favourite course of reading, degrade him to a level with writers infinitely his inferiors both in use and entertainment. An excellent apology has been made for his imperfections by the editor of his life, written by himself, and published in 1772; which is so interesting, that he must be an incurious inquirer, indeed, who, having dipped into it, is not sufficiently fascinated by the original simplicity of the style and importance

WOOD.

of many of the anecdotes, to give it an entire perusal before he lays it down. Anthony Wood was credulous, and perhaps too much an enthusiast in music to speak of its effects with critical and philosophical precision; however, without his assistance, the state of the art at Oxford, and the academical honours bestowed on its professors, as well as memoirs of their lives and works, would have been difficult to find. Upon his decisions in matters of taste, we are not always perhaps implicitly to rely. The high character he has given Dr. Willon's productions and abilities may have proceeded from want of experience, knowledge, and penetration into the finer parts of the art; and as to Dr. Rogers, his judgment of him seems to have been manifestly warped by friendship. Yet, upon the whole, it must be allowed that it is only from such minute records as those of Anthony Wood that any true and satisfactory knowledge can be acquired of the characters, manners, and domestic occurrences of our ancestors. The great features of history, and the events which occasion the ruin or prosperity of a state, must be nearly the same in every age and country; but comforts, conveniences, and the distresses of private life, furnish the mind with reflections far more varied and interesting to the generality of mankind, than the rise of states or downfall of kings and heroes.

WOOD, —, a performer on the violin, who led the band many years at the theatre in Covent Garden, and father of — Wood, his successor in that orchestra, organist of St. Giles's, and of Chelsea college. They were both active professors; but though performers only of the second class, they constantly ranked themselves of the first. Burney.

WOOD, in *Vegetable Anatomy*, is that more or less hard and compact substance, which makes up the bulk of the trunk and branches of a tree or shrub, and is concealed from view by the bark. When cut transversely, the wood is found to consist of numerous concentric layers, very distinct in the fir, and the trees of cold or temperate countries in general; less so in those appropriated to a tropical climate. The external part of each circular layer being much the most hard and compact, often with somewhat of a horny appearance, distinguishes the limits of each. Scarcely any two layers of the same tree are precisely alike, in the proportion which this compact part bears to the rest; nor does any one layer exhibit a precise uniformity of diameter in its whole circle. On the contrary, each layer is broader on that side of a tree where the exposure has been most favourable to its growth, where, consequently, there have been more branches and leaves, so as to yield a greater deposit of woody matter. Hence the layers being all, for the most part, broadest on one side of a tree, their aggregate disproportion throws the common centre, or pith, very much out of the actual centre of the trunk. It having been remarked in felling trees, that the greatest breadth of the concentric circles is very often on their south side, a rule has been proposed for travellers to ascertain thereby the direction of the compass. But travellers must be strangely at a loss, if they could find no easier method of judging. Nor is the mode in question infallible. It would indeed shew on which side the growth of each particular tree had been most favourable, whether from its exposure, or the nature of the soil which its roots had met with; but this may not always be towards the south. We must stay to fell great part of a forest, to form a precise opinion; and the process would be, as it were,

“ ——— to tell what hour o' the day,
The clock did strike—by algebra.”

The number of these concentric layers, in any tree,
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if it be found to the heart, very correctly demonstrates the number of years the trunk has been growing. This is a general opinion, and undoubtedly correct, provided the layers are well marked. The observer must be aware that each annual layer is composed of a great number of thinner and scarcely distinguishable ones, which occasionally assume a more conspicuous appearance than usual, in consequence of fluctuating seasons, or any accidental checks in the growth of a tree, as hard winters render the outside, or horny part, of each circle, more decided; while favourable summers make the circle itself altogether broader. But there is always a sufficient distinction between summer and winter, beyond the tropics, to establish the above rule. Ever-greens, for the most part, and trees of hot countries, exhibit slighter traces of these concentric layers; but they may be discerned in every mahogany table. Monocotyledonous plants have been said to be entirely without any such annular structure. But there is no reason why they should necessarily be so. Mr. Salisbury once demonstrated this structure to us in a *Dracæna*; and its absence in palms and ferns is to be attributed to a peculiar mode of depositing wood in these plants, rather than to their being monocotyledonous. What has been said already under the articles *CIRCULATION of Sap*, and *CORTEX*, will sufficiently explain this. As the inner surface of the bark deposits the matter of the wood, it must lie in concentric circles; and in proportion as this operation goes on more constantly and uniformly, these layers must be the more homogeneous and uninterrupted. Perennial roots of herbaceous plants often exhibit concentric circles, of annular formation, even in hot climates, as may be seen in Jalap. Each circle, no doubt, marks the increase which has taken place in each successive season; and while the herb is not growing, nothing is added to the root.

The theory of vegetation, as explained in the articles just cited, shews the reason of the spiral-coated vessels being found in the young wood only, and not in the bark. Those vessels, formerly supposed to contain air alone, are the real arteries of the plant, and convey its sap, or blood, through the wood, to be returned through the bark, where it deposits particular secretions. This theory also explains why the *alburnum*, as being the layer of unhardened wood for the present year, is tender, and even a mere jelly, at one period. But the bark is in the spring of the year, before the deposit of wood begins, most readily stripped from the tree; though it also readily, and without harm to the tree, comes off in winter, while vegetation is at a stand.

We scarcely need here detail the experiments of Du Hamel, to determine whether the wood forms the bark, or the reverse. Thin metallic plates introduced between these two parts, and carefully bound up, shewed, after a few seasons, when the branch thus treated was cut across, that the bark had deposited layers of wood on the outside of these foreign substances, with little or no prejudice to the growth of the plant. But Dr. Hope's experiment (see *CORTEX*) is still more strikingly decisive. The Linnæan hypothesis, that the pith added a layer every year to the wood internally, is thus entirely set aside. Indeed nothing but a preconceived theory, of the great importance of the pith, and its analogy to the medullary or nervous system of animals, (for the support of which opinion arguments are not wanting,) could have led to so erroneous a conclusion. It is sufficient to remark, what indeed could not escape the intelligent author of this hypothesis, that trees grow vigorously, though their heart

is become rotten by age, when the pith, with numerous adjoining layers of wood, have long since been obliterated.

A transverse section of the wood of a tree displays various vessels, and other parts, which microscopic authors take delight in exhibiting; but, without a scientific explanation, little is to be learned from their plates, however beautiful to the eye. Siliceous petrifications, of oak-wood especially, fine specimens of which are brought from Hungary, shew its vascular structure in the greatest perfection. In the sections to which we have just alluded, the pith, with its highly cellular texture, makes a conspicuous appearance in the centre. In the body of the wood, the sap-vessels are generally the largest and most numerous. These, when young and tender, easily display their spiral coats, if pulled asunder longitudinally; but are not found at all in the bark. Among them, in the resinous trees like the fir, or any that abound with secreted fluids, as the fig, much larger vessels are interspersed through the wood and bark, in which the peculiar secretions are lodged. But besides the determinate and continued concentric layers of wood above-described, numerous thin plates are interspersed, known to workmen, especially in oak-wood, by the name of the SILVER GRAIN. (See that article.) Mr. Knight, who is there quoted, further remarks, that if a board of English oak be cut for a floor, in such a direction, that the *laminae* of the silver grain lie parallel with the surface of the board, it is rarely or never seen, when properly laid, to deviate from its true horizontal position. But a board sawed, on the contrary, across the silver grain, "will, during many years, be incapable of bearing changes of temperature, and of moisture, without being warped; nor will the strength of numerous nails be sufficient entirely to prevent the inconvenience thence arising. That surface of a board of this kind which grew nearest the centre of the tree, will always shew a tendency to become convex, and the opposite one concave, if placed in a situation where both sides are equally exposed to heat and moisture." *Knight, Phil. Trans. for 1801, 345.* This writer adds, that the small clefts in the surface of an oak-tree, stripped of its bark, and exposed to the sun and air, are caused by the plates of the silver grain having parted from each other. They will long continue to open and close again with the changes of the weather. In the middle of a dry day they are open, but much less so during the night. After long exposure to the air and light, wood loses this property. *Knight* as above.

A different degree of hardness, and in some trees a remarkable difference of colour, exists between a number of the external concentric layers of the wood, and about as many or more of those next the centre. These latter are called the heart of the timber; the former the sap or *alburnum*; but these are vulgar appellations, and the latter especially are improper. The true *alburnum* is the layer of new unhardened wood of the present year, which also workmen often term the sap. The SAP, properly so called, is the fluid from which all their secretions, and even the wood itself, are formed. (See that article.) Those who use wood for mechanical purposes are well aware of the above difference between its different parts, however incorrect the names by which they are distinguished. The softer external layers have little durability in comparison with the heart. They retain more of the vital principle, and more of the peculiar juices of the plant in a fluctuating condition, liable to be acted upon by external or internal causes, and not yet united, in a fixed state, to the solid body of the old

wood. This change, however, is not limited in any particular kind of tree to a determinate period in the age of each layer of its wood, nor even to any determinate series of the concentric circles of any individual tree. It often extends to a greater number of rings on one side than on another. The more vigour there is in a tree, or in any side or portion of its trunk, the sooner is the *alburnum*, to use its popular denomination, made perfect wood, or heart.

The term wood, philosophically speaking, is not confined to the substance of a tree. The central part of a root, distinguished from its bark, is the wood, and in many perennial roots consists, as we have already mentioned, of several distinct layers. In a carrot, the yellow part is the wood, encompassed by a thick reddish bark. In a turnip, the woody part is of ample dimensions, while the bark is thin.

A most remarkable difference exists between the solidity of the wood in some trees and in others. Some wood is so heavy as to sink in water; some is as light as cork, or even lighter. In general, wood of different trees, of the same natural order, possesses similar properties and the same degree of value. But there is often, in the same genus, a most remarkable difference between the fitness of the wood of different species, for particular purposes. The oaks (see *QUERCUS*) abundantly exemplify this fact. The very hard and ponderous timber of *Q. Ilex*, the live oak, however lasting in a dry situation, is so prone to destruction when exposed to wet, as to be among the most worthless in the world; its hardness and heaviness only rendering it the less fit for use, where it would be likely to endure. On the other hand, many of this genus afford timber more or less useful in every circumstance and situation, among which our English *Q. Robur* stands pre-eminent. See *TIMBER*.

All kinds of wood are to be preserved from the worm, and from many other occasions of decay, by oily substances, particularly the essential oils of vegetables. Oil of spike is excellent, and oil of juniper, turpentine, or any other of this kind, will serve the purpose; these will preserve tables, instruments, &c. from being eaten to pieces by these vermin, and linseed-oil will serve in many cases to the same purpose; probably nut-oil will do also, and this is a sweeter oil, and a better varnish for wood.

The ingenious Dr. Hales, whose attention was uniformly directed to schemes of domestic or national benefit, was induced by the great damage done to shipping by worms to propose various methods for preventing it. Oily, unctuous materials, he apprehends, are not likely to penetrate deep into oak, which has a watery sap; but oil is known to penetrate far into fir, and to give it a very considerable degree of toughness. He therefore proposes to mix with oil applied to the fir-boards with which ships are sheathed some ingredient that is disagreeable to the worms; and he apprehends that a small proportion of verdigrise used in the operation of paying would be of great service: or if copperfilings were mixed with the paying, sea-water would turn them into verdigrise. It might be useful to soak planks in water strongly impregnated with verdigrise.

Mr. Reid recommends the trial of the acid juice of tar, prepared either with copperas or ochre, for preserving ships either from rotting or worms.

In the East Indies, it is said, they have an effectual way of preventing worms from destroying their ships, by paying them first with a mixture of mustard, oil, and lime of shells, and hog's blood: they then sheath the ship, and renew it after some years.

The following receipt has been recommended by a person who never knew it fail of success. Take 100 lbs. of the
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finest pitch; melt it over a slow fire of coal, and add to it, when melted, 30 lbs. of rolled brimstone grossly bruised, and boil the whole till 30 lbs. are wasted. The matter thus prepared must be kept in casks in a dry place; and when it is to be used, melt 100 lbs. of it, and add gradually 35 lbs. of brick-dust or marble-dust, sifted and well heated. The composition, when used, must be very hot, and the boards dry.

An ingenious ship-builder observes, that turpentine and brimstone form the best composition he has met with, and comes home from a voyage with least damage.

East India ships are first sheathed, and that sheathing is filled with small broad-headed nails, which is a safe and effectual defence from the worms, and soon becomes a continued cake of rust, and not liable to be damaged by cables, or common accidents. See *PAY* and *SHIPS*.

The following, says Dr. Hales, is an approved method of preserving the boards and timber of out-door work: *viz.* melt 6 lbs. of pitch, and add, by sifting, 1 lb. of dried brown Spanish, or whiting, and a quart of linseed oil. Hales's *Ventilators*, part i. p. 164. part ii. p. 289, &c.

Dr. Lewis observes, that though tar has been used for preserving wood, and also for coating common tiles, in imitation of the black glazed tiles, which are sold at a much higher price, both tar and pitch are of themselves too soft for these intentions, being liable to be melted off by the summer heat: and, therefore, different powdery substances, as ashes, ochres, and other mineral pigments, have been mixed with them.

In the Swedish Transactions for 1740 and 1742, two compositions are recommended, which are said to be firm, durable, and glossy. One is prepared by melting the tar over a gentle fire, so as to make it fluid, but not to boil, and stirring in as much coal-dust or powdered charcoal as will render it thick: the other is prepared by mixing the melted tar with a sufficient quantity of lamp-black. Coatings formed of these mixtures are, however, liable to be considerably softened by the heat of the sun. The mixture of powdered pit-coal and melted tar, made of such a consistence as to be freely spread while warm with a brush, is less liable to soften than either of the other two. The tar obtained from coal, in the method lately discovered by the earl of Dundonald, appears from various testimonies of those who have tried it to be much better calculated to preserve wood and iron, as well on land as in water, than vegetable tar. It has also this peculiar advantage, that it will not admit or harbour those worms that are so injurious to the bottoms of ships at sea. See an *Account of the Qualities and Uses of Coal and Coal-varnish, &c.* by the Earl of Dundonald, 8vo. 1785.

Mr. Parkes recommends, for the preservation of wood, the tar which is obtained from the pyroligneous acid. See *TAR*.

Dr. Lewis observes, that the coating or painting of wood does not in all cases contribute to its preservation: unless the wood be very thoroughly dry, especially those kinds of wood whose juices are not oily or resinous, the painting, by confining the watery sap, hastens the corruption. *Com. Phil. Techn.* p. 363, &c. On this subject, see *TIMBER*.

Some of the West India trees afford a sort of timber which, if it would answer in point of size, would have great advantages over any of the European wood, in ship-building for the merchant-service, no worm ever touching this timber. The acajou, or tree which produces the cashew-nut, is of this kind; and there is a tree of Jamaica, known by the name of the *white-wood*, which has exactly the same

property, and so have many other of their trees. *Phil. Transf.* N^o 36.

To season wood expeditiously for sea-service, it has been usual to bake it in ovens.

The art of moulding wood is mentioned by Mr. Boyle as a desideratum in the art of carving. He says he had been credibly informed of its having been practised at the Hague; and suspects that it might have been performed by some menstruum that softens the wood, and afterwards allows it to harden again, in the manner that tortoise-shell is moulded. Or, perhaps, by reducing the wood into a powder, and then uniting it into a mass with strong but thin glue. And he adds, that having mixed saw-dust with a fine glue made of isinglass, slightly straining out what was superfluous through a piece of linen, the remainder, formed into a ball and dried, became so hard as to rebound when thrown against the floor. *Works abr.* vol. i. p. 130. See *GLUE*.

The people who work much in wood, and that about small works, find a very surprising difference in it, according to the different seasons at which the tree was cut down, and that not regularly the same in regard to all species, but different in regard to each. The button-mould makers find that the wood of the pear-tree, cut in summer, works toughest; holly, on the contrary, works toughest when cut in winter; box is mellowest when it has been cut in summer, but hardest when cut about Easter; hawthorn works mellow when cut about October, and the service is always tough if cut in summer. *Merret's Notes on Neri*, p. 263.

It is a very well-known quality of metals to be longer and larger when hot, and shorter and smaller when cold; a thousand experiments prove this, and the books of experimental philosophy have sufficiently expatiated upon it; on the contrary, it is found to be the property of wood, that it is longest in cold weather and shortest in hot; this change is owing to the remains of the sap yet in the wood, which being condensed by cold, is enlarged in its surface, as all liquors are, when frozen into ice; and shrinks into a less space or bulk again, when liquated by heat.

It follows from this that all wood must change its surface more or less, according as it contains more or less sap, and this may be made a test of great use for the determining what kinds of wood have most, and what least sap. This would be a very valuable piece of knowledge, since there are many uses for which that sort of wood must always serve best, which has the smallest quantity of sap remaining in it. See *HYGROSCOPE*.

Thus, in the great article of preserving flour, no barrels are at present used but those of seasoned dry oak; the whole advantage of this wood is, that it contains less sap than others; for the sap in the wood makes the flour damp, and it then becomes rancid, and breeds worms. (See *MEAL*.) So that if any other wood can by this means be found out to contain less sap, when dried in the common way, than oak does, it will be so much the better for this purpose; or, if a cheaper wood should be found only to contain as little sap as the oak, it would do as well, and the price of oak would be saved in these vessels.

A proper way of trying when the sap was sufficiently exhaled out of trees, might also be found by this experiment, and much benefit would accrue from it; for our ships, when made of timber not sufficiently dried, prove injurious to the health of people on board; and it has been remarked, both by the French and ourselves, that many more men in general die in the first voyage of a new ship than in the same time in an old one; and indeed the first six months are usually observed

served in this case to be most fatal. The exhalation of the sap from the wood of the vessel is certainly the occasion of this, and if it could be contrived to have this sap properly exhaled before the timber was used, it would not only prevent this mortality among the men, but the vessel itself would be the fonder and the better for it. Deslandes, *Trait. de Phyl.*

Woods are distinguished into divers kinds, with regard to their natures, properties, virtues, and uses. Of wood, considered according to its qualities, whether useful, curious, medicinal, &c. the principal is that called timber, used in building houses, laying floors, roofs, machines, &c. See **TIMBER.**

Woods valued on account of their curiocity are, *cedar, ebony, mahogany, walnut-tree, box, calambo, &c.* which, by reason of their extraordinary hardness, agreeable smell, or beautiful polish or grain, are made into cabinets, tables, combs, beads, &c.

The medicinal woods are, *guaiac*, which the Spaniards call *ligno santo*; *aloes*, or *agalochum*; *sassafras*, *nephriticum*, *santal*, *logwood*, *asphaltum*, *eagle-wood*, or *pan d'aquilo*, &c.

Woods used in dyeing are, the *Indian wood*, *Brazil*, *Campêche*, &c.

In extracting the colouring-matter of dye-woods, and in making some other colours for the use of calico-printers, Mr. Parkes observes (*Chem. Ess. vol. ii.*), that it is of great consequence to heat the vessels by steam; for by this method of preparing decoctions, the workmen are prevented from ever giving the materials a greater heat than that of 212° ; and the injury which was formerly done by the burning of the grosser matters at the bottom and sides of the copper is avoided. Several manufacturers, says this ingenious chemist, have now adopted this method. This leads us to take notice of a beneficial application of charcoal, as a slow conductor of caloric, for preserving an equable temperature. Ground charcoal, it is said, will conduct heat more slowly than even dry sand, in the proportion, according to Guyton, of three to two. Accordingly, all those vessels which are heated by steam, if they were made double, and the space between the inner and outer vessel filled with ground charcoal, the heat would be so prevented from escaping, that any given temperature might be maintained for a long time, and thus there would be a material saving in the article of fuel. Moreover, when churches or other large buildings are to be warmed by steam, those parts of the conducting-pipes which are not within the buildings should be always surrounded in this manner, and then no heat could escape until it had been conveyed to the space which it was intended to warm by it. Thus also in the manufactories of starch, paper, gunpowder, blue, and a variety of other articles, every part of the apparatus for drying these by steam, and which is not actually within the drying-rooms, ought to be secured in the same way. The common steam-working apparatus, and other culinary utensils, would be much improved by being fitted with double covers, and by filling up the intermediate spaces with carbonaceous matter. Moreover, by securing the conducting-pipes in this manner, buildings might be effectually warmed, and processes conducted at any distance from the boiler, as steam is the most faithful carrier of heat that can possibly be; for it cannot deposit it on any bodies that have already acquired the temperature of 212° . It is also this non-conducting property of charcoal that renders it so common, says Fourcroy, cited by Parkes, in France as a material for coating furnaces, and for confining the heat, to which use its incombustible nature adapts it in a peculiar manner, as it is the most refractory body that

is known, provided it be excluded from oxygen. Charcoal is applicable to other purposes in domestic economy; such as the preserving of animal food from taint, by covering it with a few pieces of fresh-burnt charcoal, and the recovery of it by boiling it for some minutes in water with a few ounces of such charcoal. By the same means, molasses or treacle may be deprived of its disagreeable taste, so that it might be used instead of sugar. A patent has likewise been taken out for refining sugar by means of charcoal by M. Cronstat, who required for it, of the joint body of sugar-bakers in London, a remuneration of 50,000*l.*; and Mr. Parkes apprehends, that in a small concern of this kind established in the metropolis, which manufactures double loaves of a finer quality than those of any other house, the purpose is effected by the same means. The empyreumatic flavour acquired by some brandies in distillation may be removed, says the ingenious writer now cited, by digesting them in charcoal; and common malt-vinegar, boiled on charcoal, becomes colourless, without losing its strength. Water, which in long voyages acquires a disagreeable taste and smell from long standing in the wooden casks, may be purified by filtration through ground charcoal; or it may be kept sweet in casks that have been charred within side.

For the above-mentioned purposes, the charcoal should be fresh made, or heated red-hot under a cover of sand, immediately before it is used; and the requisite quantity should be previously ascertained by experiment. In some cases, it should be used in the form of powder, having been pounded immediately from the fire, before it has been exposed to the air, and the residue should be preserved for future use in bottles closely stopped. For other uses to which charcoal is applied, see **CHARCOAL** and **CARBON.**

Wood used for fuel is required of various kinds, in regard to the various works to be performed by it.

Neri every where commends oak for the wood to be burnt in the glass-houses, as the properest wood for making a strong and durable fire with a good flame.

Imperato, on the contrary, commends ash on the same occasion; because, as he says, it gives a substantial rather than a great flame: and Camerarius deservedly commends juniper wood, as affording a lasting, strong, and sweet fire, could plenty of it be had. Among the ancients, Pliny commends light dry wood; and Plutarch, the tamarisk in particular, for making the glass-house fires; but glass-making requires so great a fire, as cannot be easily made from such wood. Nor can ash be proper, because, though it gives a good fire, it soon decays. Merret's Notes on Neri, p. 275.

If wood be burnt in the open air, the greatest part of it will be dissipated in gas. Common oak, properly charred, will lose only from $\frac{3}{4}$ ds to $\frac{1}{7}$ ths of its weight; whereas, if the same kind of wood be burnt in an open fire-place, the residuum of the combustion will not be more than about $\frac{1}{10}$ th, or $\frac{1}{15}$ th of the original weight of the wood employed. Dr. Watson says, that he obtained 22 grains of charcoal from 96 of dry oak: others have given different results. From Neumann (*Chem. vol. ii.*) we learn, that for the reduction of the metallic oxyds, the charcoal of the heavier woods, *e. g.* that of the oak and beech, is preferable; and that, for common fuel, such charcoal gives the greatest heat, and requires the most plentiful supply of air to keep it burning, while those of the lighter woods preserve a glowing heat with a much less draught of air; and that for purposes which require a steady and still fire, charcoal made from wood previously divested of its bark should be employed, as it is the cortical part which crackles and flies

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off in sparks during combustion, which the coal of the wood itself seldom does. The charcoal of wood is said to be essential to the perfection of bar-iron; but when wood became scarce, and government restricted its use, cinders and coke were substituted for it; and thus the quality of English iron was so much debased, that Russian and Swedish iron, which is prepared by means of the coal of wood, are employed by those who work in this metal. The superiority of the iron made with charcoal is attributed by M. Hassenfratz to its combination with potassium. It was by 1 Eliz. c. 15. that it was enacted, that no oak, beech, or ash-timber, one foot square at the stub, should be converted into charcoal for making iron in any part of England or Wales, except in the county of Sussex, the weald of Kent, and certain parishes in the county of Surrey. This restriction led to the practice of making bar-iron with the coke of pit-coal, the method of preparing which was kept a secret from the generality of the trade. When Mr. Henry Horne published his "Essays on Iron and Steel," in the year 1773, he gave directions for a better method than they had before known of charring pit-coal, so as to make it a proper succedaneum for wood-charcoal in the manufacture of iron. Since that time the coke of pit-coal has come into very general use, so that the consumption of this substance is now very considerable. (See COKE.) Crayons of charcoal are best made of the willow; whereas the coals of the hard woods, such as box and guaiacum, are much harder than others, whilst the charcoal of the kernels of fruits is quite soft and friable. As a pigment, the coal of ivory, or that which is procured by burning real ivory in closed vessels, is the most intensely black, and the most beautiful. The best charcoal for use as a powder for cleaning the teeth is made from the shell of the cocoa-nut. The difference between the charcoals of animal and vegetable substances may be determined by the following test. A vegetable coal will burn on a red-hot iron into white ashes, which will be readily dissolved by sulphuric acid into a bitterish liquor; whilst the ashes of animal substances are little affected by that acid, and form with it a compound with a very different taste. (See ASHES, CARBON, CHARCOAL, and GUN-Powder.) For the method of charring wood, see TIMBER and CHARRING of Posts. This appears to have been a very ancient practice. The piles that formed the foundations of the Temple of Diana at Ephesus, not long since taken up, appeared to have been charred; and about fifty years ago some oak-stakes were found in the bed of the Thames in the very spot where Tacitus says that the Britons fixed a number of such stakes, to prevent the passage of Cæsar's army; and these stakes, which were charred to a considerable depth, had completely retained their form, and were firm at the heart. About sixty years ago one of the timbers that supported Trajan's bridge over the Danube, near Belgrade, was taken up, and the outer part, to the depth of half an inch, was found to be converted into an agate, the inner parts being slightly petrified, and the central being still perfect wood, though this timber had been in the water 1700 years. (See Kirwan's Geological Essays, cited by Parkes in his Essays, vol. ii.) Many other instances occur of wood petrified and converted, more or less, into agates of various colours. Writers on this subject have recommended the practice of charring every piece of wood before it is placed in the ground. Dr. Watson, (late bishop of Landaff,) in his "Chemical Essays," vol. iii. suggests the propriety of charring all the wood that is used in mines and subterraneous drains, and particularly that which covers troughs, through which a current of water passes, and which rot in a few years by the alternate change of wet and

dry. In this connection we may add, on the authority of Chaptal, in his "Chemistry applied to the Arts," that when old chestnut and other trees are rotted within the trunk, and threatened with speedy destruction by the progress of the carious trunk, it may be stopped by applying fire to the decayed part, so as to char the whole of the neighbouring surfaces.

WOOD, in *Gardening*, is a term used to signify the shoots or branches left in fruit-trees. See PRUNING, &c.

WOOD, an epithet applied to various sorts of weeds. See WEED.

WOOD and Bark of Trees, *Canker or Erosion of*, in *Agriculture and Gardening*, a diseased state in these parts of them. It has been stated by a late philosophical writer, that the cause seems to be an excess of alkaline and earthy matter in the descending sap, as he often found carbonate of lime on the edges of the canker in apple-trees; and that ulmin, which contains fixed alkali, is abundant in the canker of the elm. The old age of a tree, in this respect, is, it is thought, faintly analogous to the old age of animals, in which the secretions of solid bony matter are always in excess, and the tendency to ossification great.

It is suggested, that perhaps the application of a weak acid to the diseased part might be of use; or that where the tree is of great value, it might be watered occasionally. See CANKER.

WOOD, *Lignin?* in *Chemistry*, the substance which constitutes the basis of wood usually so called.

To obtain this substance in a state of purity, it is necessary to digest wood in a sufficient quantity of water and afterwards of alcohol, by which means all foreign substances soluble in these fluids will be removed; the simple *woody fibre* will thus remain, which possesses the following properties.

It is composed, in general, of longitudinal fibres easily separable from one another. These fibres, when very much subdivided, become somewhat transparent. They have no smell nor taste, and are not altered by exposure to the atmosphere.

The woody fibre is insoluble in water and alcohol. It is soluble in a weak alkaline solution without being decomposed, and may be again separated by an acid. Concentrated alkaline solutions render it brown, and decompose it, especially when assisted by heat.

When heated it becomes black without melting, exhales strong acrid fumes, and leaves a charcoal, retaining exactly the form of the original mass. When distilled in close vessels it yields an acid liquor, of a peculiar taste and smell, called the *pyroligneous acid*, and which was properly considered as a distinct acid. Fourcroy and Vauquelin, however, long ago demonstrated, that it consists of nothing but the acetic acid combined with an empyreumatic oil. (See ACETOUS and PYROLIGNEOUS Acid.) Pure acetic acid is now prepared from wood both in this country and France.

The fibre of different woods has been analysed by Gay Lussac and Thenard by means of the oxymuriate of potash. The following are the results:

	Oak.	Beech.	Mean.
Oxygen	41.78	42.73	42.25
Carbon	52.53	51.45	52.00
Hydrogen	5.69	5.82	5.75
	<hr style="width: 50%; margin: 0 auto;"/>	<hr style="width: 50%; margin: 0 auto;"/>	<hr style="width: 50%; margin: 0 auto;"/>
	100.00	100.00	100.00

Wood when burnt with a smothered flame leaves, as is well

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well known, a quantity of charcoal behind. The following is the proportion yielded by one hundred parts of different woods, according to the experiments of Proust :

Black ash	-	-	-	25
Guaiacum	-	-	-	24
Pine	-	-	-	20
Green oak	-	-	-	20
Heart of oak	-	-	-	19
Wild ash	-	-	-	17
White ash	-	-	-	17

Count Rumford, by continuing a very moderate fire for ninety-six hours, procured much larger proportions of charcoal from different woods than were obtained in the above experiments of Proust. According to this chemist, one hundred parts of different wood yielded,

Poplar	-	-	-	43.57
Lime	-	-	-	43.59
Fir	-	-	-	44.18
Maple	-	-	-	42.23
Elm	-	-	-	43.27
Oak	-	-	-	43.00

The woody fibre, when completely burnt, always leaves a certain proportion of earthy and saline matters, which constitute the *ashes* of wood. Different woods yield very different proportions of ashes. See **ASHES** and **CHARCOAL**, where other experiments by Mr. Musket on this subject are related.

The following Table exhibits the quantity of ashes left by different woods, according to Saussure junior. Saussure has extended the investigation to herbaceous and other plants; but we have omitted these, from their not being immediately connected with the present subject. See **CARBON**.

Table of Incinerations.				Constituents of 100 Parts of Ashes.					
Names of Plants.	Ashes from 1000 Parts of the Plant.		Water from 1000 Parts of the Plant. Green.	Soluble Salts.	Earthy Phosphates	Earthy Carbonates	Silica.	Metallic Oxysds.	Loss.
	Green.	Dry.							
Wood of a young oak, May 10	—	4	—	26.	28.5	12.25	0.12	1.0	32.58
Bark of ditto	—	60	—	7.	4.5	63.25	0.25	1.75	22.75
Perfect wood of oak	—	2	—	38.6	4.5	32.0	2.0	2.25	20.65
Alburnum of ditto	—	4	—	32.0	24.0	11.0	7.5	2.0	23.5
Wood of black poplar, Sept. 12	—	8	26	—	16.75	27.0	3.3	1.5	24.5
Bark of ditto	—	72	—	6.0	5.3	60.0	4.0	1.5	23.2
Wood of hazel, May 1	—	5	—	24.5	35.0	8.0	0.25	0.12	32.2
Bark of ditto	—	62	—	12.5	5.5	54.0	0.25	1.75	26.0
Perfect wood of mulberry, November	—	7	—	21.0	2.25	56.0	0.12	0.25	20.38
Alburnum of ditto	—	13	—	26.0	27.25	24.0	1.0	0.25	21.5
Bark of ditto	—	89	—	7.0	8.5	45.0	15.25	1.12	23.13
Perfect wood of hornbeam, November	4	6	346	22.0	23.0	26.0	0.12	2.25	26.63
Alburnum of ditto	4	7	390	18.0	36.0	15.0	1.0	1.0	29.0
Bark of ditto	88	134	346	4.5	4.5	59.0	1.5	0.12	30.38
Wood of horse-chefnut, May 10	—	35	—	9.5					

See Dr. Thomson's System of Chemistry, vol. iv. 5th edit.

Wood, *On making Bread from*. Professor Autenrieth, of Tubingen, has lately attempted to make bread from wood, and his experiments seem to have been attended with considerable success. He had been led to form the opinion that the woody fibre was only rendered unfit for food from the foreign substances usually attached to it, and from its compact aggregation. The first of these difficulties he attempted to obviate, by selecting those woods which have little taste and smell, and which consequently contain less foreign matters; such, for example, are the birch and beech, especially the birch, which was the wood he chiefly employed in his experiments.

To render wood alimentary, it is necessary to reduce it to a state of extremely minute division, or absolute powder. It also requires the repeated action of the heat of an oven, by which means it is not only better fitted for being ground, but probably also undergoes some internal change which renders it more digestible, as is evidently the case in regard to coffee. Wood prepared in this way acquires the smell and taste of corn-flour. It is, however, never white, but always yellowish. It also agrees with corn-flour in requiring the addition of some leaven, to enable it to undergo the

fermentative process, and the four leaven of corn-flour is found to answer the best. With this it makes a perfectly uniform and spongy bread, like common brown bread; and when it is thoroughly baked, and has much crust, it has a much better taste of bread than what in times of scarcity is prepared of bran and husks of corn.

To make wood-flour in perfection, the wood, after being thoroughly stripped of its bark, is to be sawed transversely into disks of about an inch in diameter. The saw-dust is to be preserved, and the disks to be beaten to fibres in a pound-mill. The fibres and saw-dust mixed together are next to be deprived of every thing harsh and bitter, and which is soluble in water, by boiling them in a large quantity of water when fuel is abundant, or by subjecting them for a longer time to the action of cold water, as by placing them in a rivulet, for example, enclosed in a sack. The whole is then to be completely dried, either by the sun or fire, and repeatedly ground in a flour-mill till it pass through the bolting-cloth.

The ground wood is next to be baked into small flat cakes, with water rendered slightly mucilaginous by the addition of some decoction of linseed, or any other similar substance. Professor Autenrieth prefers marsh-mallow roots,

of which one ounce renders eighteen quarts of water sufficiently mucilaginous, and these serve to form four pounds and a half of wood-flour into cakes. These cakes are to be baked in an oven until they are quite dry, and become of a brownish-yellow colour on the surface. After this they are to be broken to pieces, and again ground repeatedly, until the flour pass through a fine bolting-cloth, and upon the fineness of the flour does its fitness to make bread depend. The flour of a soft wood, such as birch, will be sufficiently prepared by the process as described; but the flour of a hard wood will require the steps of baking and grinding to be repeated.

That the wood thus prepared is altered in its nature and rendered soluble, is proved by the quantity of real starch that is obtained from it by the same process, by which it is separated from wheat-flour. If wood-flour tied up in fine linen be long kneaded in a vessel of water, the water is rendered milky, and deposits slowly a quantity of starch, which with boiling water forms a thick, tough, trembling, tenacious jelly, like that of wheat-starch, and it is only necessary to see this starch to be convinced that the wood-flour is soluble and nutritious. This starch cannot be ascribed to the mucilaginous matter added to the ground wood before it is baked, as the added mucilage does not amount to more than the one-hundred and forty-fifth part of the wood, whereas the wood-flour loses about half its weight by the separation of the starch. The residuum left in the linen seems to be the woody fibres unchanged, which have not been ground sufficiently fine.

Wood-flour does not ferment so readily as wheaten-flour; but professor Autenrieth found fifteen pounds of birch-wood flour, with three pounds of four wheat leaven, and two pounds of wheat-flour, mixed up with eight measures of new-milk, yielded thirty-six pounds of very good bread. The best mode of preparing it was to mix up the five pounds of wheat leaven and flour with a portion of the wood-flour and milk to a preparatory dough; let it stand for some hours in a moderately warm place to rise, and then to knead in thoroughly the rest of the wood-flour and milk. This dough is rolled out into thin cakes, allowed to stand in a warm place to rise for a longer time than wheat-flour requires, and lastly to be put into the oven and baked thoroughly.

Professor Autenrieth made many experiments upon animals, as well as upon himself and family, in order to ascertain the nutritious properties of wood-flour, in the various forms of soup, dumplings, cakes, &c.; and he found that it was not only very palatable in all these forms (especially when combined with milk or some fatty substances), but also sufficiently nutritious, and that it did not disorder the digestive organs, or apparently produce any other ill effects.

From these experiments, it is obvious, says the writer from whom we have made these extracts, that in cases of necessity wood may be made to furnish a considerable quantity of nourishment; but it is no less obvious, that the process is so troublesome and expensive, that it never can become an article of food, except where there is an absolute scarcity of provisions. On such occasions the labour is of very secondary importance, and at any rate cannot be so profitably applied as in procuring the means of subsistence.

In some districts of Norway and Lapland, the bark of the fir is manufactured into a species of bread, apparently much inferior in quality to the bread of wood-flour, and this with dried fish and a little rein-deer tallow constitute the chief articles of food among the lower classes, during the protracted and rigorous winter of these inhospitable climates. See Von Buch's Travels in Norway and Lapland.

WOOD, *Distillation of*. See CHARCOAL, COLOUR, GUN-Powder, PYROLIGNEOUS Acid, and WOOD *supra*.

WOOD, *Tenacity and Strength of*. See COHESION and STRENGTH of Materials.

WOOD and Wood, a term in ship-building, implying that when a tree-nail, &c. is driven through, its point is directly even with the inside surface, whether plank or timber.

WOOD, *Cord*, denotes wood for the fire, generally the branches or loppings of trees, piled up in order. See CORD.

WOOD, *Fossil, Subterraneous*. There are divers places where wood is found under ground: supposed to have been overturned, and buried there from the time of the Deluge, or at some other period.

Whole trees, or parts of them, are very frequently found buried in the earth, and that in different strata; sometimes in stone, but more usually in earth; and sometimes in small pieces loose among gravel. These, according to the time they have lain in the earth, or the matter they have lain among and in the way of, are found differently altered from their original state; some of them having suffered very little change, and others being so highly impregnated with crystalline, sparry, pyritical, or other extraneous matter, as to appear mere masses of stone or lumps of the common matter of the pyrites, &c. of the dimensions, and more or less of the internal figure of the vegetable bodies, into the pores of which they have made their way.

The fossil wood, which we find at this day, may, according to these differences, be ranged into three kinds: 1. The less altered. 2. The pyritical. And, 3. The petrified.

Of the trees or parts of them less altered from their original state, the greatest store is found in digging to small depths in bogs, and among what is called peat or turf-earth, a substance used in many parts of the kingdom for fuel. In some places there are whole trees scarcely altered except in colour; the oaks in particular being usually turned to a jetty black: the pines and firs remain as inflammable as ever, and often contain between the bark and wood a plain resin. Parts of trees have been also found unaltered in the strata of clay and loam, among gravel, and sometimes even in solid stone. See Fossil PLANTS, and Bog WOOD.

It is idle to imagine, that these have been thus buried either at the Creation, or, as many are fond of believing, at the universal Deluge: at the first of these times the strata must have been formed before trees were yet in being, and the peat wood is so far from being of antediluvian date, that much of it is well known to have been growing within these three hundred years, in the very places where it is now found buried. See MORASS.

The substances that are more altered are the larger and longer branches of trees found bedded in the strata of stone, and partly assuming its nature; and the shorter and smaller branches found in pits of blue clay, which externally bear the resemblance of what they once were, but, having their pores filled with the matter of the common vitriolic pyrites, internally appear to be masses of that matter.

The irregular masses or fragments of wood are principally of oak, and most usually found among gravel, but variously altered by the insinuation of crystalline and strong particles. These make a beautiful figure when cut and polished, as they commonly keep the regular grain of the wood, and shew the several circles which mark the different years growth. These, according to the different matter which has filled their pores, assume various colours, and the appearance of the various fossils that have impregnated them. Of these some pieces have been found with every pore filled with

with pure pellucid crystal, and others in large masses, part of which is wholly petrified, and some mere stone, while the rest is crumbly and unaltered wood.

All these pieces of petrified wood are usually capable of a high and elegant polish. Hill.

Wood has been found in salt-mines, inclosed in a mass of hard salt, and its pores filled with the matter of the salt in which it lay. Wood has likewise been found converted as it were into iron, or thoroughly impregnated with the particles of this metal. Aët. Erud. ann. 1710.

Wood, *Petrified*. The opinions of the judicious part of the world have been very different in regard to the bodies preserved in the cabinets of the curious, under the name of petrified wood; some affirming these bodies to have been only pebbles, or flints accidentally formed in this shape, and with veins resembling those of the wood; and others affirming with equal warmth, that they have been really wood, into which stony matter has been brought by water.

Many substances, it is certain, have been preserved in the cabinets of collectors, under the title of petrified wood, which have very little right to that name. But where the whole outer figure of the wood, the exact lineaments of the bark, or the fibrose and fistular texture of the stræ, and the vestiges of the utriculi and trachææ or air-vessels are yet remaining, and the several circles yet visible, which denoted the several years growth of the tree, none can deny such substances to be real fossil wood.

Many good arguments have been produced on both sides the question, but M. De la Hire has attempted to bring the dispute to a certain conclusion, by means of some peculiarly happy specimens, which were of the palm-tree petrified, found in the deserts of Africa: these on comparing them with pieces of the palm-tree cut out of the recent wood, appeared to have every where the beautiful and regular veins of that wood, and left no room to doubt but that they certainly had been once the vegetating wood of that tree, though now converted into hard stone; the petrified pieces were perfect stone, in all its qualities; they had its hardness, its sound when struck upon, and were, as many other stones are, opaque in some places, and transparent in others; they were found on weighing them to be often of the specific gravity of recent pieces of the palm wood of the same dimensions.

Father Duchat also, an author of unquestioned credit, affirms, from his own personal knowledge, that in the kingdom of Ava there is a river whose waters petrify recent wood into flint; and that he has often seen trees standing in it, whose bottom part, so far as covered with the water, has been true flint, while all above was mere dry wood, and fit for firing. Mem. Acad. Par. 1692.

Wood, *Shining*. There are a great many things in which a piece of rotten wood that shines in the dark agrees with a burning coal; and there are also many things in which they differ. They agree in these particulars: 1. They have light residing in them, and are not like bodies which are only luminous according to the quantity of light which falls upon them from other bodies, and which they reflect. 2. Both shining wood and burning coals require the presence of the air to keep them shining, and both require also an air of a considerable density; and both having been deprived of their shining quality by the pumping out of the air, will recover it again on the admitting of fresh air to them. 3. Both of them will easily be quenched by putting them into water, and many other liquors. And, 4. As a live coal will not be extinguished by any coldness of the

air, neither will the shining wood be deprived of its light on any additional coldness in that element.

However, they differ in the following particulars: 1. A burning coal is easily put out by compression, the treading on it and squeezing it together readily divesting it of its light; on the other hand, compression or crushing of any kind seems not to have any effect upon the shining wood; its bruised parts shining as brightly as its entire ones. If a piece of this shining wood be squeezed between two glasses, this experiment will be most fairly tried; and in this case, though the contexture of the whole be evidently broken, and the parts separated, the light is as strong in them as while the piece was entire. 2. A burning coal extinguished by the drawing out of the air will, after a few minutes, be irrecoverable, on the admission of air in any manner; but, on the contrary, the shining wood, when thus extinguished and kept extinct for half an hour, will be immediately re-kindled on admitting the air to it. 3. A live coal, included in a small glass, will continue shining but a few minutes; but a piece of shining wood, in the same circumstances, will continue bright for several days. 4. The coal, while it burns, sends forth smoke and other exhalations; the rotten wood sends out none, and consequently a coal all the while that it is shining wastes itself at a great rate; but the rotten wood does not waste itself at all. And finally, the burning coal is actually and vehemently hot; the rotten wood, though it shines, is not so much as warm. Phil. Transf. N^o 32.

The light of shining flesh and fish, when putrefied, is wholly of the same nature with that of rotten wood, as to its dependence on the air for its splendour; and in the same manner loses its light in the exhausted receiver, and regains it on the admission of the air into it again, in the same sudden manner. Phil. Transf. N^o 31. See LIGHT, and PUTREFACTION.

WOOD, *Bog*, or *Subterraneous*, a name given by the inhabitants of many parts of this kingdom to such wood as is found buried in the earth in boggy places, and which is found hard and strong at this time. See Fossil WOOD *supra*.

We have in the Philosophical Transactions (N^o 275. p. 983, &c.) an account of vast quantities of this sort of wood found under ground in Hatfield Chase. Many of the roots and bodies of trees are found there; which are of all growths, and are mostly such trees as are the growth of our own soil, such as oaks, firs, birch, beech, yew, holly, willow, ash, and the like. The roots of all these trees stand in their natural positions as when growing, and stand as thick together as they could grow in a forest. The bodies are usually broken off, and laid all along just by them.

The large trees are usually found fallen in a north-east direction, and the smaller ones lying all ways; the fir-tree or pitch-tree is more common than any other kind, and is found sometimes of twenty, thirty, and thirty-five yards long, and so found and firm that many of them have been sold to make masts for ships. Oaks have been found of the same length, though wanting some yards of their natural tops; these have been sold at ten or fifteen pounds a piece, and are as black as ebony, and very sound and lasting in whatever service they are put to. The ash-trees do not preserve their firmness in this manner, many of them are so soft that the workman's spade cuts through them; and when exposed to the air, they usually fall to pieces; but the willows, though a much softer wood than the ash, preserve their texture, and are found very strong and firm. In some of the fir-trees it is very observable, that they have shot out-

outside branches after they were fallen, which have grown into large trees. Many of these fossil-trees appear plainly to have been burnt; the fir-trees are particularly very common in this state: and of these some are burnt quite through, others only on one side. Some of these also have been found with the plain marks of human work upon them; many with their branches chopt off, and their trunks cut into two or three pieces. Some squared and others in part cleft, and the wooden wedges used in cleaving them are still found remaining in the cracks. Stones are found in some of them in the place of wooden wedges, but in none iron ones. The heads of axes are also sometimes found; they are of a strange form, and somewhat represent the sacrificing axes of the ancients. These are found at such depths, that it is impossible they should have ever been lodged there since the time of this place's being a forest; nor ever could have been found, but by means of the ground's being drained by a late invention. The general opinion as to these trees is, that they were buried in this manner at the time of the universal Deluge; but they are plainly of later origin as fossils, the coins of some of the Roman emperors having been found buried under them.

The earth of bogs is not the only soil that preserves these trees; for in the low parts of Lincolnshire, between the towns of Burningham and Brumley, there are several large hills composed only of loose sand, and as this blows away there are continually discovered whole trees, or parts of trees, and particularly the roots and stumps of firs, and some other kinds, all with the marks of the axe upon them, and looking as fresh as if done but yesterday. Under these hills, and in the bogs before-mentioned, not only the wood of the fir-tree, but its cones are found in immense number; many buhels being often laid in a heap together. In cutting a drain for a river of a considerable depth, there were found at the very bottom several parcels of cut wood, in poles, beams, and the like; the head of an axe was also found somewhat resembling the ancient battle-axe, and a coin of the Roman emperor Vespasian; but what was yet more remarkable was, that what they were now sunk to seemed to be the original surface, the ground not being loose, like all above it, but found and firm, and lying in ridges and furrows, with the evident marks of having formerly been ploughed. So that all the bog-earth above seems plainly to have been added since; and that the fossil wood, supposed of antediluvian origin, is but of the time of the ancient Romans, or less than that.

All the bogs in this kingdom afford in like manner fossil-trees; and not only those, but other places, have at all times accidentally discovered them. Giraldus Cambrensis tells us, that so long since as in king Henry the Second's time, the sands on the shores of Pembrokeshire were driven off by peculiar storms and tempests, and that deep under those sands there were then discovered great numbers of the roots and bodies of trees in their natural postures; and many of these had the strokes of the axe upon them, the marks at that time remaining as plain as when first made. Some of these resembled ebony; and many other such trees were discovered at Neugall in the same county, in the year 1590. Camden tells us of such wood found in the bogs in Somersetshire, Cheshire, Lancashire, Westmoreland, Yorkshire, Staffordshire, and Lincolnshire; and since his time many other counties have been found to be as fruitful in it. Dr. Plot mentions them in many parts of his History of Staffordshire, and by their standing in their natural postures, as to the roots at least, properly concludes, that they certainly once grew there, and were not brought from elsewhere.

Dr. Leigh, in his History of Lancashire, gives an account of the same sort of trees found in the draining of the boggy lands at Martin-Meer; and determines them not to have been of the ancient date many pretend, in referring them to the Deluge.

He observes, that they are plainly of no older date than the time of the savage inhabitants of England, about the time of the Roman conquests; for in this place, beside the roots and bodies of trees and their fruit, there were found eight canoes, or small boats, such as the wild inhabitants used at that time. And in another moor in the same county, a brass kettle, with a small mill-stone, and some beads of wrought amber. In the same place were also found several human bodies whole and entire, at least to outward appearance, and the whole head of an hippopotamus, or river-horse. This is perhaps the hardest thing to be accounted for of the whole set, as to its coming there. The boggy places, in Anglesea, and the Isle of Man, are all full of buried trees of the same kind; and the bogs of Ireland abound no less with them. England, and its adjacent islands, are not the only places where this buried wood is found; for Vertegan tells us, that the moors in the Netherlands abound with them; they all lie north-east, as our's do. Helmont also mentions the Peel there, a morass of eight or nine miles broad, which is full of them. The French naturalists tell us of fossil-trees also in their country; and in Switzerland and Savoy; but all in the low grounds.

Ramazzeni tells us, that in the territories of Modena, which are now a dry and fruitful country, yet in the time of the Cæsars were only a great lake, there are found at the depth of thirty, forty, and even fifty feet, the soil of a low marshy country, with sedges, water-grass, and other marsh-weeds; and under this there lie the trunks of trees, and their roots stand near them in as natural a posture as when growing. Many old coins of the Roman emperors are also found there; as also several busts, wrought marble, and squared stones, evidently shewing the work of such tools as the Romans have been known to use. Some of the trees in these places stand upright. See more on this subject under the article MORASS.

WOOD, *Cutting of.* See CUTTING.

WOOD, *Measure of.* See MEASURE.

WOOD, *Stack of.* See STACK.

WOOD, *Staining of.* See DYEING of Wood, &c.

Wood may be stained yellow, by brushing it over several times with the tincture of turmeric root, made by putting an ounce of the powdered root to a pint of spirit, and after it has stood some days, straining off the tincture. A redder cast may be given to the colour by adding a little dragon's blood. A cheaper, and less bright and strong yellow may be given to wood by rubbing it over several times with the tincture of French berries, made boiling hot; and when the wood is dry, brushing it over with a weak alum-water used cold.

In order to render these stains more beautiful and durable, the wood should be brushed after it is coloured, and then varnished with the seed-lac varnish, or with three or four coats of shell-lac varnish.

For a bright red stain for wood, make a strong infusion of Brasil in stale urine, or water impregnated with pearl-ashes in the proportion of an ounce to a gallon; to a gallon of either of which add a pound of the Brasil wood. With this infusion, after it has stood, with frequent stirring, two or three days, strained and made boiling hot, brush the wood over till it appears strongly coloured; and while it is wet, brush it over with alum-

water made in the proportion of two ounces of alum to a quart of water.

For a less bright red, brush over the wood with a tincture made by dissolving an ounce of dragon's blood in a pint of spirit of wine.

For a pink or rose red, add to a gallon of the above infusion of Brasil wood two ounces of pearl-ashes, and use it as before: observing to brush the wood over often with the alum-water. These reds may be varnished as the yellows.

Wood may be stained blue by means either of copper or indigo. The brighter blue may be obtained by brushing a solution of copper (see VERDITER), while hot, several times over the wood: and then brushing a solution of pearl-ashes in the proportion of two ounces to a pint of water hot over the wood. It is stained blue with indigo, by brushing it with the indigo prepared with soap-lees as when used by the dyers, boiling hot; and then with a solution of white tartar or cream of tartar, made by boiling three ounces of either in a quart of water, brushing over the wood plentifully before the tincture of indigo be quite dry. These blues may be brushed and varnished as the reds, if necessary.

Wood may be stained green by dissolving verdigrise in vinegar, or the crystals of verdigrise in water, and with the hot solution brushing over the wood till it be duly stained.

A light red-brown mahogany colour may be given to wood by means of a decoction of madder and fustic wood, ground in water, in the proportion of half a pound of madder and a quarter of a pound of fustic to a gallon, or, instead of the fustic, an ounce of the yellow berries may be used. Brush over the wood with this solution, while boiling hot, till the due colour be obtained. The same effect may to a considerable degree be produced by the tincture of dragon's blood and turmeric root, in spirit of wine.

For the dark mahogany, take the infusion of madder as above, and substitute for the fustic two ounces of logwood: and when the wood has been brushed over several times, and is dry, brush it over slightly with water in which pearl-ashes have been dissolved, in the proportion of about a quarter of an ounce to a quart. The wood, in the better kind of work, should be afterwards varnished with three or four coats of seed-lac varnish; but for coarse work, with the varnish of resin and seed-lac, or they may be well rubbed over with drying oil.

Wood may be stained purple by brushing it over several times with a strong decoction of logwood and Brasil, made in the proportion of one pound of the logwood and a quarter of a pound of the Brasil, to a gallon of water, and boiled for one hour or more. Let the wood, well coloured, dry, and be then slightly passed over by a solution of one drachm of pearl-ashes in a quart of water. A solution of gold in spirit of salt or aqua regia will give a durable purple stain to wood.

For a deep black the wood is brushed over four or five times with a warm decoction of logwood, made as above without the Brasil, and afterwards as often with a decoction of galls, made by putting a quarter of a pound of powdered galls to two quarts of water, allowing it to dry thoroughly between the several applications of the liquors: thus prepared, it receives a fine deep black colour, from being washed over with a solution of vitriol in the proportion of two ounces to a quart: in the room of which some use a solution of iron in vinegar, keeping the vine-

gar for this purpose upon a quantity of the filings of the metal, and pouring off a little as it is wanted. A pretty good black is also obtained, more expeditiously, by brushing over the wood, first with the logwood liquor, and afterwards with common ink.

A very fine black may be produced by brushing the wood several times over with a solution of copper in aqua fortis, and afterwards with the decoction of logwood, repeated till the colour be of sufficient force, and the greenness produced by the copper overcome. The blacks may be varnished as the other colours.

Where the stains are desired to be very strong, as in the case of wood used for fineering, it is generally necessary it should be soaked, and not brushed; for which purpose the wood may be cut into pieces of a proper thickness for inlaying. Lewis's Phil. Com. Techn. p. 97. 434. Handmaid to the Arts, vol. i. p. 508, &c.

WOOD, *Stealing of*. See LARCENY.

WOOD, *Engraving on*. See WOOD-ENGRAVING, *infra*.

WOOD, *Painting on*. See PAINTING.

WOOD, *Sculpture in*. See SCULPTURE.

WOOD, *Sylva*, in *Geography*, a multitude of trees, extended over a large continued tract of land, and propagated by nature, or without culture.

Many great woods only consist of trees of one kind. At Cape Verd, in Africa, are woods of orange and lemon trees; in Ceylon, are woods of cinnamon-trees; in the Molucca islands, woods of clove-trees; in the islands of Nero, Lontour, Lofgain, &c. woods of nutmeg-trees; in Brasil, woods of Brasil-trees, &c.; in Numidia, woods of date-trees; in Madagafcar, woods of tamarind-trees, &c.

WOOD-*Ashes*, in *Agriculture*, the ashes which are formed by burning wood.

The ashes of some sorts of wood, too, are found to be more powerful as a manure than those of others, as those from the ash and some other such trees.

It is said by some that they are an excellent dressing for improving cold wet pasture land; and that poor hungry pastures have been very profitably benefited by them, to near double their former value; that nothing equals them on low spongy pasture land. Others, however, have tried them on grass-lands with little or no effect.

The difference in the burning and forming of them may probably cause this difference in the effects which they have on land.

WOOD-*Bound*, a term used to signify such land as is encumbered with tall woody hedge-rows, so as to prevent the free circulation of air and admission of the sun, by which the natural fertility and strength of it cannot be fully exerted or brought into action. See WOOD-LAND.

WOOD-*Coppices*. In the first raising of coppices, two things are to be considered; first, the nature of the soil, that such trees may be planted in it as will thrive well there; and secondly, the uses that the wood is intended to be sold for, that such kinds may be planted as will be most proper for those uses.

If the principal vent for wood be for the fire, the best trees for fire-wood must be planted, such as the oak, beech, hornbeam, or other hard wood. These are the most profitable for felling as fire-wood, and one or more of these grow in any soil.

If there be a demand in the country where the coppice is to be planted for hoops and hop-poles, then the ash, the chestnut, the oak, alder, and hazel, are to be planted.

According

According to the profits of the underwood, the thickness of the standard-trees is to be regulated; for as they stand more or less thick, they more or less injure the underwood. It is also to be considered at what growth the underwood is to be sold. The taller and larger the underwood of a coppice in general is, the more profitable will it be for firing, and all other uses, and the standards will be the better for its being left to grow to a proper height, for their bodies will be always, unless very great accidents occur, carried up straight as far as they are shaded by the coppice-wood.

A deep soil makes the shrubs as well as trees grow more vigorously than any other, and they will be sooner fit for cutting in such places. The person who owns these woods must contrive to cut down only a certain quantity of them every year, and regulate this so that he may have a constant succession of a like quantity; that part of the wood which was at first felled, may be grown up to its size for felling again by the time the last is cut. This is, in different places, to be calculated to all the various numbers between eight years and twenty or thirty.

The cutting of wood seldom yields the more and the better timber; but the cutting of it oftener has greater advantages, in that it makes it grow thicker, and gives the seedlings time to come up. If many timber-trees grow in the coppice, and are to be cut down, they and the underwood should be felled together, cutting off the stumps as close to the ground as may be, in the trees, and in the shrubs and underwood the stumps should be left about half a foot high, and cut slanting and very smooth.

Sawing is the best method of felling timber-trees; but it sometimes kills the root; and if this is observed to be the case in the coppice, no new shoots arising from the root, then it is proper to stub up the root, that it may not unnecessarily encumber the ground, and that the other young plants may have the benefit of it.

In the first raising of coppices from seed, the ground must be prepared by good tillage, as much as if it were intended for corn. The seeds of the several trees are to be sown in February, and if the soil be shallow, the ground should be ploughed into great ridges: this will make the soil lie the thicker upon the top of each ridge, by which means the roots will have more depth to run to for nourishment, and in a few years the furrow will be filled up to the level of the rest with the dead leaves; and these, as they rot at the bottom, will make a kind of soil, through which the young shoots will spread, and be conducted from one ridge to another, and so the whole ground will be occupied by them. If the coppice be to be raised on the side of a hill, plough the ridges cross-way of the descent of the hill, that the water may be detained among them, and not suffered to run off, as it otherwise would by the furrows; but if it happen that the ground be over-wet, which is more rarely the case, then the contrary method is to be observed, and the furrows ploughed deep and straight downwards, that all water may be carried off by them, as by so many trenches or drains.

Some sow a crop of corn along with the seeds of the underwood, for the advantage of the first year; but as the season of sowing the seeds of the trees is too late for the sowing of the corn, it seldom turns to much advantage. It is better to sow the trees alone, and keep them well weeded the two first years; after which they are strong enough to take care of themselves against such enemies.

In very barren ground, where the young trees can hardly stand the heat in summer, it is proper, after sowing

them, to scatter a quantity of furze-feed over the land; the furze will grow quick, and over-top the trees at first, but it will serve as a guard to them at this time, defending them from injuries, and keeping the ground moist about their roots. In a few years the trees will grow up beyond these bushes, and they will then soon destroy them by their dropping.

In the raising of coppices, the nearest distance for the plantations ought to be five feet for the underwood, but as to what number, and scantlings of timber are to be left on each acre, the statutes in this case direct; but it is an ordinary coppice, which will not afford three or four firsts, fourteen seconds, twelve thirds, and eight wavers, according to which proportion the sizes of young trees in coppices are to succeed one another. In coppice or underwood felled at twenty-four years growth, there are to be left twelve store-oaks upon every acre, or, in defect of them, the same number of elms, beech, or ash: these are to be straight-bodied trees, and are to be left till they are ten inches in diameter, at a yard from the ground; but it is better for the owner to have a much greater number of timber-trees, especially in places where underwood is cheap; and as to the felling, it is always necessary to begin regularly with one side, that the carriages, necessary to the taking off the wood, may come on without injury to the rest: and in large woods, a cart-way should always be left in the middle, quite through the wood. The timber of the underwood may be cut from the month of October to February; but the last month is much the best, in places where there is but a small quantity to be felled, and it can all be got down before the spring is too much advanced. All the wood should be carried out by Midsummer, and made up by April at the latest; for when the rows and brush lie longer than this unmade up, and unbound, many of the shoots and seedlings are spoiled by them. It is always worth the owner's while to inclose the coppice well the winter before felling, to keep out the cattle, which would else greatly damage the supply from the seedlings and young shoots.

New-weaned calves are the least prejudicial to newly cut woods of any creatures, and may be put in where there is much grass; the next in harmlessness to these are young colts, which, at about a year old, may be put in to feed in the same manner; but about May they must all be put out.

If the woods happen to be cropped by cattle, it is best to cut them up, and they will make new shoots; for that which has been bitten by the cattle will not grow for several years in any degree.

If the coppice-woods are too thin, this is to be remedied by laying down the longest and smallest shoots of those shrubs or trees which are the most advantageous, in the place, or of such as are nearest the bare place; these will each send forth a great number of suckers, and the whole wood will be thickened as much as desired in a very little time. Mortimer's Husbandry, vol. ii. p. 64. See COPPICE.

WOOD, *Almiggim*. See ALMIGGIM.

WOOD *Anemone*. See ANEMONE.

WOOD-*Bine*, or *Wood-bind*, in *Botany*, a species of *lonicera*; which see.

WOOD-*Bind*, *Spanish*, a species of *ipomoea*; which see.

WOOD-*Chat*, in *Ornithology*, *lanius minor primus* of *Aldrovandus*, a species of butcher-bird, with a horn-coloured bill; the feathers at the base are whitish; above is a black

black line drawn across the eyes, and then downwards on each side the neck; the head and hind part of the neck are of a bright bay; the upper part of the back dusky; the coverts of the tail grey; the scapulars white; the coverts of the wings dusky; the quill-feathers black, having a white spot at the bottom; the throat, breast, and belly of a yellowish-white; the legs black. In the female, the upper part of the head, neck, and body, are reddish, striated transversely with brown; the lower parts of the body are of a dirty white, rayed with brown; the tail of a reddish-brown, marked near the end with dusky, and tipped with red. Pennant.

Wood-Cock, Scolopax rusticola of Linnæus, called by other writers *la becaffe*, a well-known bird distinguished by its size, which is somewhat smaller than that of the partridge, and by its colour, which is on the back a variegation of black, grey, and a reddish-brown; on the forehead the black predominates; the quill-feathers are dusky, indented with red marks; and on the belly a pale grey, variegated with transverse streaks of brown. Its beak is three inches long, dusky toward the end, and reddish at the base, and the upper chap a little longer than the under: the tongue slender, long, sharp, and hard at the point; the eyes large, and placed near the top of the head, that they may not be injured when the bird thrusts its bill into the ground: from the bill to the eyes is a black line; the forehead is a reddish ash-colour; the chin is of a pale yellow; the tail consists of twelve feathers, dusky or black on the one web, and marked with red on the other; the tips above are ash-coloured, below white: the legs and toes are livid, the latter divided almost to their origin, having only a very small web between the middle and interior toes.

These birds, during summer, are inhabitants of the Alps, Norway, Sweden, Polish Prussia, the Mark of Brandenburg, and the northern parts of Europe; whence they emigrate at the approach of winter into milder climates, where the ground is open and adapted to their manner of feeding. The time of their appearance and disappearance in Sweden coincides exactly with that of their retreat from and arrival in Great Britain. They live on worms and insects, which they search for with their long bills in soft ground and moist woods. They generally arrive here in flocks, taking advantage of the night or a mist; they soon separate: but before they return to their native haunts, pair. They feed and fly by night; beginning their flight in the evening, and returning the same way to their day-retreat.

They leave England the latter end of February, or beginning of March; though they have been known to continue here accidentally. In Casewood, near Tunbridge, a few breed almost annually. During incubation they are very tame. They come over to the coast of Suffolk sparingly in the first week of October, the greater number not arriving till the months of November and December, and always after sun-set. They are determined in their flight by the wind, and arrive separate and dispersed. When the red-wing appears on the coast in autumn, the wood-cocks are at hand; and when the Royston crow is arrived, they are come. Between the 12th and 25th of March they flock towards the coast to be ready for their departure, having the red-wings for their harbingers in spring, as in autumn. If the wind be favourable, they immediately depart; but otherwise, they are detained in the neighbouring woods, or among the ling and furze on the coast: as soon as a fair wind springs up, they are suddenly gone.

In the same manner they are known to quit France, Germany, and Italy; making the northern and cold situations their general summer rendezvous. In the winter they are found as far south as Smyrna and Aleppo, and also in Barbary; and some have appeared as far south as Egypt, which seems to be the limit of their migration in that way. In Japan they are found very common. Those that resort into the countries of the Levant probably come from the deserts of Siberia or Tartary, or the cold mountains of Armenia.

Our species of wood-cock is unknown in North America; but they have a sort of wood-cock resembling ours in its general appearance; about half its size, and wanting the bars on the breast and belly. Pennant.

They hate flying high, and they are afraid to fly among trees, because, like the hare, they see but very badly straight before them; and it is owing to this imperfection in their sight, that they are so easily taken in nets spread in their places of resort.

The draw-net, in countries which are very woody, is extremely profitable in this sport, it being no uncommon thing to take ten or a dozen wood-cocks at a time in it.

There is another method of taking these birds in high woods, with those nets called *hays*, of the nature of the rabbit-hays, only with smaller meshes. The wood-cocks are to be driven into these, and there should always be at least two or three of them planted together. When the sportsman has provided himself with nets, he is to take five or six persons into the wood with him. The proper woods for this purpose are those of seven or eight years' growth; and the people are to go into some part of them near the middle. The nets or hays are to be placed in the same manner as they are for taking of rabbits, but two or three joining together at the end, and hanging over slopewise that way which the wood-cocks are intended to be driven.

The nets being thus fixed, let the company go to the end of the wood, placing themselves at about ten rods distance from one another; they must all have sticks in their hands, and they are to move forward slowly towards the nets, making a noise by striking the sticks against the trees and branches, and by hallooing with their voices: in this manner they are to move up to the net; and the wood-cocks in that part of the wood will all be terrified before them, but will not take wing, but run along upon the ground, and thus be driven along like a drove of beasts, so that when the company come up, they will find almost all of them in the net. When that part of the wood is thus driven, the nets are to be turned the other way, and placed slopewise in the contrary direction, and the company retiring to the other end of the wood, are to drive the wood-cocks that are in that part with the same noise, till they have sent them into the nets in the same manner.

Thus all the wood-cocks in the wood may be taken with very little trouble, and this may be done equally at any time of the day.

Another way of taking this bird is by means of noozes or springs.

The wood-cock and the snipe are both easily taken with bird-lime, when their places of resort are known, but they are not so easily found as many other birds.

The custom of the wood-cock is usually to be upon the banks under hedges, and by the sides of ditches toward the sun; and they will suffer the sportsmen to come nearer them in the day-time after a moon-shiny night, than after a dark one. The reason of which is, that having fed well by moon-light, they are only fit for rest the day following;

but

but when the night has been dark, they are seeking food all day long.

The snipes naturally lie by the sides of rivers, when the plashes and ponds are frozen, and they always lie with their heads up or down the stream, never transversely.

In order to take either of these birds by bird-lime, the sportsman must be provided with a large number of small and smooth twigs, neatly and evenly covered with good bird-lime. These must be placed sloping, some one way, some another, and the whole place about where they resort must be covered with them. The sportsman then must conceal himself very carefully, that the sight of him may not frighten away the game. See *COCK-ROAD*.

WOOD-COCK Apple, in *Rural Economy*, a fine cyder fruit. See *APPLE-Tree*.

WOOD-COCK Shell, a name given by the English naturalists to a peculiar kind of the purpura. It is called in French, *becasse*, from the length of its beak. There are two species of this, a prickly and a smooth one.

The prickly kind is an extremely beautiful and elegant shell. It is of a yellowish colour; and its tail or beak (for the hinder extremity of the shell, which runs out into an immoderate length, is sometimes called by the one, sometimes by the other of these names) is furnished with four rows of large and very long spines: between the rows of these, there are also rows of small and short spines. The body of the shell is furrowed very deep, with a number of transverse circular lines; and both this and the clavicle are beset with several rows of long spines.

The smooth *becasse*, or wood-cock shell, is a very elegant species, but much less so than the other. It is of a yellowish colour, radiated with black and grey lines. It is all over deeply furrowed, and the ridges are beset with tubercles, the clavicle is elevated, and the tail extremely long, and hollowed into a sort of tube. The mouth of this, as well as of the other, is small and roundish, and in this species is of a light flesh-colour.

WOOD-COCK Soil, in *Agriculture*, a term applied to such land as has the mould of a dapple-brownish colour, and which is said not to be of a good quality for many purposes. See *SOIL*.

WOOD-CORN is a certain quantity of oats, or other grain, anciently given by customary tenants to their lord, for the liberty to pick up dead or broken wood.

WOOD-EVIL, or *Cramp in the Legs*, a disease among sheep, which is so named in consequence of its being supposed in general to arise from the drippings of trees in cold and wet weather. It shews itself by seizing the legs of the sheep, and making them totally incapable of walking; and will sometimes all at once spread through the whole flock.

In regard to the means of cure, a tea-spoonful of the flour of mustard has been advised to be given every night and morning. The affected parts should also be well rubbed with warm flannel, and the sheep be kept dry, which are very effectual aids. The use of a little oil of turpentine externally may often also be advantageous, where the other mode of rubbing does not succeed: and in bad cases the use of mild mercurials with opium may be had recourse to with much benefit.

WOOD-FUEL, Saw for cutting of, in *Rural Economy*, a tool used for this purpose. On the continent they employ an improved instrument of this kind, the iron part of which consists of a saw, three inches in breadth, and sixteen inches in length, double toothed, in the manner of the gardener's pocket saw, and fixed in a frame of tough ash-wood, as below. The edge part of the saw is made broader than the

back, in order that it may work more freely and with greater ease.

The frame of the saw at the top part has a strong cord tied round each side of it, so as to tighten the saw and keep it from bending, being capable of being twisted tighter by a small thin piece of wood put between the double cord, and which may be kept from untwisting by being rested against the cross-bar in the upper part, which is mortised and firmly fastened into the two side pieces, being the only means that keeps the frame together in a safe manner. The side pieces are each twelve inches in length; and the additional length of the handle part of one of them five inches. It is evident that this saw will, on the principle of lessening friction, and of keeping the cutting part from bending, work with much greater facility and expedition than the common carpenter's saw.

With this wood-saw twice as much work may be done in a day as with the common hand-saw that is in general use in this country.

WOOD-GELD, Woodgeldum, in our ancient customs, the gathering or cutting of wood within the forest. Or it may denote the money paid for the same to the foresters. Sometimes it also seems to signify an immunity from this payment, by the king's grant. Crompton says expressly, it signifies to be free from the payment of money for taking of wood in a forest. See *GELD*.

WOOD-HAY, an ancient custom at Exeter; by which a log out of every seam of wood brought over Ex-bridge is taken towards the reparation of that bridge. *Antiq. of Exeter*.

WOOD-LAND, in *Agriculture*, a term used by the farmers of many counties of England for a sort of soil, from its constant humidity and dark colour, resembling the soil in woods, which, of whatever nature it originally is, will always be made to appear thus from the continual dropping of trees, and the want of a free air and sun, together with the fall of leaves, destroyed and washed to pieces by the wet.

This soil in the open countries has a considerable quantity of clay in it, and holds the water a long time that once falls upon it: in wet weather it sticks firmly to the plough-share, and in dry is very apt to crack. In uncultivated places it usually produces rushes and rush-grafs. A moist and dripping year is extremely detrimental to this sort of land.

As to the clearing of wood-land in order to bring it into a state of cultivation and improvement, the first step is that of properly digging out the roots of whatever sorts they may be, after the wood has been cut off, to prepare the ground for the operation of the plough, without mixing the under stratum of the land with the fertile surface mouldy layer of earth. The hollows and pits are then to be filled and levelled.

In some instances it may be beneficial to encourage and promote the sward and herbage by sowing over the surface suitable grass-seeds, after it has been broken and spread over with the collected and decayed or burnt woody and leafy matters, stocking the land hard with sheep, and mowing off occasionally the wood-shoots that may arise; thus keeping the whole in a state of close pasturage, until the smaller root parts that may have been left in the land become sufficiently decayed, to render them obedient to the plough, when the land may be broken up for corn. The use of lime and calcareous substances in mixture with these matters, or spread alone over the land, would also serve to encourage the finer sorts of herbage, the delight of sheep; and, of course, induce them to eat the grass more close, and

and bring the land sooner into the state of a thick set sward, the productive matrix of corn-crops.

WOOD-Lark, in *Ornithology*. See **WOOD-LARK**.

WOOD-Layer, in *Agriculture*, a term used to signify the young oak or other timber plants which are laid down into hedges, among the white thorn or other plants used in fences. See **HEDGE**.

WOOD of Life, in *Botany*. See **GUAIAACUM**.

WOOD-Lock, in *Ship-Building*, a piece of elm, closely fitted and sheathed with copper, in the throating or score of the pintle, near the load-water-line; so that when the rudder is hung, and the wood-lock nailed in its place, it cannot rise, because the latter butts against the underside of the brace and butt of the score.

WOOD-Louse. See **MILLEPEDES**.

WOOD-Meil, a coarse, hairy kind of stuff, made of Iceland wool, with which the ship-carpenters, in some of his majesty's yards, line the ports of ships of war.

WOOD-Mite, in *Natural History*, the name of a little animal frequently made the subject of microscopical observations, and by some called the *wood-louse*; though that less properly, as there is another larger animal generally known by that name.

The wood-mite is in shape and colour very like a louse, and is frequently found running very nimbly, but always by starts and jumps, on old books and rotten wood. The eyes of this creature are of a fine gold colour, and can be thrust out or drawn in at pleasure; and when examined by the microscope the peristaltic motion of the guts is seen very distinctly, and beautifully; and what is more wonderful, there is observed a very distinct and regular motion in the brain.

This probably is the same animal with the *pediculus pulforius*, described by Dr. Derham, as one of the death watches. Baker's *Microscope*, p. 185.

WOOD-Men, certain forest-officers appointed to take care of the king's woods.

WOOD-Mote, the ancient name of that forest-court, now called the court of attachment.

WOOD-Pecker, in *Ornithology*, the English name of some species of *picus*.

The green wood-pecker, *picus viridis* of Linnæus, called also the rain-fowl and pluvialis avis, weighs about six ounces and a half, is thirteen inches long, and twenty and a half broad; the bill is dusky, triangular, and near two inches long; the crown of the head is crimson, spotted with black; the eyes are surrounded with black, beneath which the males have a crimson mark; the back, neck, and lesser coverts of the wings, are green; the rump of a pale yellow; the greater quill-feathers are dusky, spotted on each side with white; the tail consists of ten stiff feathers with black tips, and barred alternately with dusky and deep green; the whole hinder part of the body is of a very pale green; the thigh and vent are marked with dusky lines; the legs and feet all of a cinereous green.

The greater-spotted wood-pecker, *picus major* of Linnæus, called also *witwall*, weighs two ounces three-fourths, is nine inches long, and sixteen broad; the bill is one inch and a quarter long, of a black horn colour; the irides are red; the forehead is of a pale buff colour; the crown of the head of a glossy black; the hind part marked with a rich deep crimson spot; the cheeks white, bounded beneath by a black bar passing from the corner of the mouth, and surrounding the hind part of the head; the neck is encircled with a black colour; the throat and breast are of a yellowish-white; the vent-feathers of a light crimson; the back, rump,

and coverts of the tail, and lesser coverts of the wings, are black; the scapular feathers and coverts, adjoining to them, are white; the quill-feathers black, elegantly marked on each web with round white spots: the four middle feathers of the tail are black; the next tipt with yellow; the bottom of the two outmost black, the upper parts a dirty white; the exterior feather marked on each side with two black spots; the next with two on the inner web, and one on the other; the legs are of a lead colour. The female wants the crimson spot on the head. This species is much more uncommon than the preceding; and keeps altogether in the woods.

The middle wood-pecker, or *picus medius* of Linnæus, agrees with the preceding in size and colours, except that the crown of the head in this is of a rich crimson; the crown of the head in the male of the former being black, and the crimson in form of a bar on the hind part.

The lesser-spotted wood-pecker, *picus minor* of Linnæus, is also called *bickwall*, and has all the characters and actions of the greater kind, but is more rare. Pennant.

WOOD-Pigeon. See **RING-DOVE**.

WOOD-Plea Court, is a court held twice a year in the forest of Clun, in Shropshire, for determining all matters relating to wood, and the feeding of cattle there. Perhaps it was originally the same with wood-mote court.

WOOD-Pucerons, in *Natural History*, a name given by M. Reaumur to a small species of insect of the puceron kind, of a greyish colour, and distinguished by its two hollow horns on the hinder part of its body.

These animals very much resemble, both in shape and size, the pucerons of the alder; but as those live always on the surface of the stalk, these make their way deep into the wood of a tree.

M. Reaumur found large quantities of these lodged at a considerable depth in the wood of some elms, after they were cut down; the passages, by which they had made their way in, were not to be found; but they were lodged in large and long holes, of the diameter of a goose-quill, and running many inches along the tree in a longitudinal direction.

All the pucerons found in those places appear to be females, and none have wings; they all have vast numbers of young ones of different degrees of maturity within them, and these may be forced out with pressing their bodies. Reaum. *Hist. Insect.* vol. vi.

WOOD-Root, or *Wood-ruffe*, in *Botany*. See **ASPERULA**.

The leaves and roots dried have been esteemed aperient and diuretic; and recommended in obstructions of the liver, and thence supposed efficacious in the jaundice: but they are now disused.

WOOD-Sage. See **SAGE**.

WOOD-Soot, in *Agriculture*, a substance of the foot kind, which has been found highly beneficial as a manure in cases of cold clayey or stiff loamy soils or lands, when in either the state of pasture or in that of tillage for grain, or other arable crops.

It is stated to be used in these proportions on different sorts of land. On light loams, when for pasture, from twenty-two to twenty-four bushels on the acre; when for barley, from thirty-three to thirty-four; for turnips, from thirty-three to thirty-six.

On chalky loams, when for pasture, from twenty-three to twenty-six bushels on the acre; when for turnips, from thirty-three to thirty-eight; for barley, from thirty-five to forty.

On strong loams, when for pasture, from twenty-two to twenty-

twenty-six bushels on the acre; when for artificial grasses, or green crops, from twenty-eight to thirty-four. See *Soot* and *Wood-Soot*.

Wood-Sorrel, in *Botany*. See *Wood-SORREL*.

Wood-Spitz, in *Ornithology*, an English name given by many to the common green wood-pecker.

Wood-Wash, in *Agriculture*, a name sometimes applied to dyer's-broom by farmers.

Wood, Waxen, in *Gardening*. See *GENISTA*.

Wood, in *Geography*, a county of Virginia, with 3036 inhabitants.

Wood Creek. See *PRESTON'S Creek*.

Wood Creek, a river of New York, which runs into the Hudson, near Fort Edward.—Also, a river of New York, connected with the Mohawk by the canal at Rome, through which the navigation is extended into Oneida lake.—Also, a river of New York, which rises in Kingsbury, and runs N. by Port Anne village, into lake Champlain, at Whitehall landing, formerly Skeneborough.

Wood Island, a small island near the coast of Maine; 15 miles N.E. of Cape Porpoise. N. lat. $43^{\circ} 26'$. W. long. $70^{\circ} 24'$.

Wood River, a river of North America, which runs into the Mississippi, N. lat. 44° . W. long. $92^{\circ} 25'$.—Also, a river of North America, which runs into the Mississippi, N. lat. $38^{\circ} 25'$. W. long. $90^{\circ} 58'$.

WOODBERRY, a township of Pennsylvania, in the county of Huntingdon, with 1107 inhabitants.

WOODBIDGE, a large and populous market-town in the hundred of Loes, and county of Suffolk, England, is situated on the banks of the river Deben, at the distance of 8 miles E.N.E. from Ipswich, and 77 miles N.E. by E. from London. It is said to have taken its name from a wooden bridge built over a hollow way to make a communication between two parks, separated by the road which leads towards Ipswich; and near the spot where this bridge is supposed to have stood is a house, which to this day retains the name of the Dry Bridge. But when it is considered that in ancient times this town was written *Oddebruge*, or, as in *Domesday-book*, *Udebruge*, it may with greater probability be supposed thence to have derived its present appellation. The principal streets in Woodbridge, one of which is nearly a mile in length, contain many good houses, and are well paved. The market-place is well-built, and in the centre of it is an ancient shire-hall, where the quarter sessions for the liberty of St. Ethelred are held; under which is the place for the corn-market. A weekly market, granted in the reign of Henry III., is held on Wednesdays, and here are two annual fairs. The only manufactures are those of sack-cloth and salt: but the commerce is of great importance. The Deben, which towards its mouth is called Woodbridge-haven, is navigable up to the town, which thereby carries on a very considerable traffic in corn, flour, malt, and various other articles, with London, Hull, Newcastle, and the continent: here are several docks for building vessels, with commodious wharfs and quays. In the population return of the year 1811, Woodbridge is stated to contain 702 houses, occupied by 4332 persons. The church, a spacious structure, is considered to have been built in the reign of Edward III. by John, lord Seagrave. It consists of a nave, chancel, and two side aisles, the roofs of which are supported by fourteen beautiful slender pillars. The exterior walls are of black flints, as is also a large quadrangular tower, 108 feet in height; near the top, the flint and stone are curiously intermixed in various devices. On the south side of the church formerly stood a priory for black canons of the Augustine

order. At the dissolution the site was granted by Henry VIII. to John Wingfield. After passing through several families, the estate was divided and sold, when the capital mansion, called the abbey or priory, was purchased by Francis Brooke, esq. of Ufford. The town contains meeting-houses for Independents, Quakers, and Methodists; also a free grammar-school for ten boys, sons of the poorer inhabitants of the town, who are to be instructed in Latin and Greek, and fitted for the university. Here is likewise an alms-house, worthy of particular notice, which was founded and endowed in 1587, under a patent of queen Elizabeth, by Thomas Seckford, esq. for thirteen men and three women. The endowment was an estate in Clerkenwell, London, then let for 11*l.* 13*s.* 4*d.*; but leased in 1767 for sixty years at 563*l.* per annum, clear of all charges. And as vast sums have been recently expended upon the estate, it may reasonably be supposed that a considerable advance will take place at the expiration of the lease. The governors are the master of the rolls and the chief justice of the common pleas, who are empowered to make such regulations as from time to time shall be necessary. By the last ordinances, the annual allowance to the residents in the alms-house was increased to 27*l.* for the principal or nominal governor, and 20*l.* to each of the other twelve poor men, besides wearing apparel, and a chaldron and half of coals. The three women are appointed as nurses and attendants on the men, and receive 12*l.* per annum, and clothing. The men wear a silver badge, with the Seckford arms, and are required to attend divine service at the parish-church on Sundays, Wednesdays, and Fridays, and all holidays.—Kirby's *Suffolk Traveller*, 8vo. 1764. *Beauties of England and Wales*, vol. xiv. Suffolk, by F. Shoberl.

WOODBIDGE, a town of New Jersey; 4 miles N. of Amboy.

WOODBIDGE, a township of Connecticut, in the county of New Haven, with 2030 inhabitants; 7 miles N.W. of New Haven.

WOODBURY, a town of the state of Connecticut, in the county of Litchfield, with 1963 inhabitants; 30 miles S.W. of Hartford.—Also, a town of the state of New Jersey, on the E. side of the Delaware; 9 miles S. of Philadelphia. N. lat. $39^{\circ} 51'$. W. long. $75^{\circ} 15'$.—Also, a town of Vermont, in the county of Caledonia, with 254 inhabitants; 20 miles N. of New Haven.—Also, a township of Pennsylvania, in the county of Bedford, with 1658 inhabitants.

WOODCHESTER, a parochial village in the hundred of Longtree, and county of Gloucester, England, is situated $2\frac{1}{2}$ miles S.W. from Stroud, $12\frac{1}{2}$ S. from Gloucester, and 104 W. by N. from London. In 1811 the number of houses in the parish was 162, and the inhabitants 845. By its name Woodchester indicates its having been originally a Roman station, and many Roman antiquities have been frequently discovered there, of which the most remarkable is a mosaic pavement, partially laid open by digging graves in the church-yard under which it lies. It appeared to have formed a square of 48 feet 10 inches; and for size and richness of ornament is certainly superior to any similar tessellated pavement hitherto discovered in Britain. The tesserae were imbedded in a cement about 8 inches thick: and under all were flues crossing each other at right angles. Besides this curious work, others have been occasionally discovered at Woodchester: particularly in 1795 and 1796, the ground-plot of a very extensive Roman building was laid open, of which the remains in the church-yard formed the N. extremity, and the other parts extended under an adjoining orchard and field. The plan of this building comprised two courts,

courts, which, with the great room, containing the principal pavement, ran through the middle, having numerous apartments of different dimensions branching out from them. In three large rooms on the N. side of the great or first court were found fragments of columns, statues, and marbles. The second or inner court had galleries on three sides. The great mosaic pavement seemed to have belonged to the *cavaedium*, an interior court or hall, which communicated with several suites of rooms. Various parts of the building appear to have belonged to the apartments allotted for baths, exercise, &c. That these remains were portions of a splendid Roman villa is scarcely to be doubted; and from their character the villa may have been the residence of the pro-prætor, while Britain was subject to Rome. Fragments of statues, pottery, stags'-horns, glass, and coins, have been found among the ruins. Of the coins, the oldest was one of Hadrian, and the latest of Valens. A dagger of iron, much corroded, two spurs of the same metal, a small brass hatchet, a fibula, a key apparently of hardened clay, &c. were also discovered. The manor of Woodchester belongs to lord Ducie, who has a seat at Spring-park, in the parish, now deserted. It is romantically situated amidst fine woods. A full account of the Roman villa, with plates, has been published by S. Lysons, in imperial folio.

WOODCOCK, —, in *Biography*, one of the Hereford waits, with a strong hand on the violin, so famous in our youth for playing Vivaldi's Cuckoo concerto, that he was sent for far and near to perform it at country concerts. See **VIVALDI**.

WOODCUTTER'S CREEK, in *Geography*, a river of East Florida, which runs into the Atlantic, N. lat. $29^{\circ} 57'$. W. long. $81^{\circ} 40'$.

WOODEN, a town of Poland, in the palatinate of Lublin; 52 miles N. of Lublin.

WOODEN Ball, a small American island, near the coast of Maine. N. lat. $43^{\circ} 50'$. W. long. $68^{\circ} 40'$.

WOODEN Frames, for preserving and retarding the Blossoms of Fruit-trees, in *Gardening*, such as are contrived for the purpose of protecting the blossoms of them from the destructive effects of spring-frosts, &c. In this intention nets of different kinds, and screens of canvas rolled up in the day-time and let down at night, or in the time of heavy rains, have been mostly employed while the trees are in flower; but these frames are found to be superior, especially in exposed northern situations. By means of thus retarding and defending the blossoming of these sorts of tender trees, until the frosts be chiefly over, much advantage is said to be gained in the setting of the fruit.

These frames are constructed in a simple cheap manner; the revolving parts of which are covered with the branches of the silver fir, or those of some other such tree, which are found to answer the purpose very effectually; and when they are properly formed, they will open and shut with the greatest ease and expedition. They are in use from about the middle of February until towards the end of April, or later in some cases; being only opened as there may be a necessity in the state of the blossoms.

They have been employed with great success for peaches and apricots, and may be used for many other sorts of tender fruit-trees.

In forming them, the upright posts are made of wood, two inches square, and fourteen feet six inches long, into which cross-bars are mortised; the poles standing six feet asunder. The upper leaves, which open outward on their pivots, are made of inch-deal, by an inch and a quarter in breadth. There are small pieces of wood nailed on the insides of the upper and middle bars, to prevent the leaves of

the frames from falling inward on the wall. The lower leaves of the frames, which open out above, in order to admit the rays of the sun to the lower parts of the wall, revolve on pivots. The bottom or low end of the frames stand out two feet from the wall, and every other pole in them is fixed at the top, with an iron holdfast immediately under the coping of it. The leaves of the frames are covered with branches of the silver fir, so as to wholly occupy the vacant spaces at the end, middle, and sides of them. The cross-bars are made of inch and quarter wood, and of a breadth to correspond with the upright poles into which they are mortised. There are small wooden pins in the ends of the cross-bars, to hold the frames tight when they are up. The space between the wall and the frames should have a sort of partition at every twelve feet, formed by the silver fir-branches, tied to the trees and every second pole, which will prevent a too free circulation of air along the wall, and preserve a degree of serenity very essential to the setting of the fruit.

These frames may be found very beneficial in many open and exposed aspects of garden-grounds. See a paper on the subject in the first volume of the "Memoirs of the Caledonian Horticultural Society."

WOODEN Hoop for Cheese, in *Rural Economy*. See **DAIRYING**.

WOODEN Horse, in *Military Language*. See **HORSE, Wooden**.

WOODEN Horse-Collar. See **COLLAR**.

WOODEN Saddle. See **PACK-Saddle**.

WOODEN'S Island, in *Geography*, a rocky islet in the North Pacific ocean, on the S. coast of King George III.'s Archipelago: so called by captain Vancouver, from Isaac Wooden, one of his crew, who fell overboard near it, and was drowned, a little to the east of Cape Ommaney.

WOOD-ENGRAVING, or *Xylography*, is the art of making such incisions and hollows, imitative of natural or ideal objects, at the will of the designer, on a block or tablet of wood, as may afterward yield impressions on paper, its surface being supplied with printers'-ink in the manner of letter-types.

The wood of the apple or pear-tree, either of them occasionally, but more frequently the pear-tree, was used by those engravers of the European continent, who flourished during the 14th, 15th, and 16th centuries, and is believed to have been used for the same purpose, from a much earlier period, in China. The reason of this preference is the superior compactness of the texture of those woods: but the wood of the box-tree has latterly—for the same reason, namely, because it is yet more compact than the pear-tree in its grain, and harder in its substance—superfeded it; at least for the smaller purposes of such book-blocks as are intended to be combined in the letter-press, and printed at the same operation with alphabetic types.

The instruments used in this art are few and simple; and are probably the same now, with a few improvements of no great importance, that have been in use from the very commencement of the art: namely, *gravers*, more or less square or lozenge in their proportions, according to the breadth and depth of the lines required to be cut; *scrapers*, of various sizes, both flat and round, but chiefly the latter; *knife-tools* and *spit-slickers*, for the finer lines, pecks, or stipplings; and *gouges*, for the broader and deeper hollows, which are intended to be left untouched by the ink and paper in the process of printing.

The designs which formed the subjects of the more ancient engravers in wood, consisted either of pure outlines, or very little more than outlines; the engraved blocks or tablets

WOOD-ENGRAVING.

tablets furnishing merely the lineaments of the figures, &c. represented, and the colourist, or illuminist, (as he has sometimes been termed,) supplying the rest. By degrees a few light hatchings were introduced, thinly scattered upon the folds of the draperies, shadows of the flesh, and other parts of the design; and occasionally, when the opening of a door or a window, or the mouth of a cavern, was to be expressed, the block was left untouched, that it might print black in such places, and thereby diminish the task of the colourist. It was soon discovered, that with little additional labour of the wood-engraver, much more might be accomplished. It was easy to represent the bugbear figure of Lucifer with its appropriate blackness, and at the same time to express the internal markings of his body and limbs, by means of thin lines cut in the block, and which would be rendered white in the impression.

The ornamental borders which, in some instances, surrounded the devotional cuts of those times, were rendered more attractive to the eye, by the opposition of broadish white and black lines; and sometimes intermediate spaces of greater extent were enlivened by large white dots cut out, or perhaps punched at equal distances, on the block; or decorated with sprigs of foliage, or small flowers, relieved by a similar process, upon a black ground. Gradations of shadow next began to be attempted in the figures and other parts of wood-engravings, by means of white dots, differing from each other in their magnitude and proximity according to the degree of shade or darkness required.

This mode of finishing engravings in wood appears to have been practised at Mentz, among other places, at an early period of the invention of typography, and was afterwards occasionally resorted to by the wood-engravers of other countries; especially those of Paris, where, at the close of the 15th and commencement of the 16th centuries, numerous small books of devotion were printed by Antoine Verrard, Simon Vostre, and others, in which the borders surrounding the pages were decorated by figures very delicately engraved, and relieved upon a black ground, specked over, with extreme nicety of workmanship, with minute white dots, such as have been described.

These innovations or improvements in the art of wood-engraving, were such as involved but little additional labour or difficulty in the execution; at the same time, they were calculated to give to the decorations of books a shewy effect: but the artists of Germany, finding or fancying them to be incompatible with the purpose of imitating by wood-cuts the appearance of their original designs, the former and more simple method was again resorted to.

It appears to have been at the earlier period of the art the practice of those masters, who furnished designs for the wood-engravers to work from, carefully to avoid all cross-hatchings, which it is probable were by many persons considered as beyond the power of the xylographist to represent. Wolgemuth perceived that though it was difficult to effect cross-hatchings, it was not impossible; and in the cuts of the Nuremberg Chronicle,—the execution of which he doubtless superintended, beside furnishing the designs,—a successful attempt was first made to imitate the bold hatchings of a pen-drawing, crossing each other, as occasion prompted the designer, in various directions. To Wolgemuth belongs the praise of having been the first who duly appreciated the powers of this art; and it is more than probable that he proved with his own hand, to the artists who were employed under him, the practicability of the style of workmanship that he required.

Engraving on wood now offered inducements to its practice, which had not before been contemplated. Albert

Durer early applied himself to the study and further advancement of an art which at once promised to reward his labours with fame and fortune; and so well had Nature qualified him for the task, that before the termination of the 15th century, he produced his series of wood-cuts of the Apocalypse; a work which it cannot be doubted was received throughout Europe with wonder and universal applause.

Mr. Bartsch strongly insists that neither Durer, Schauflein, Burgmair, nor the other great designers of the German school, who were contemporaneous, or nearly so, ever engraved in wood themselves; but that all they did was to furnish the designs, leaving the task of cutting them upon the tablets to the ordinary engravers in wood. Mr. Ottley is, however, persuaded that this opinion is in a great measure erroneous, notwithstanding the inscriptions which Bartsch refers to, written anciently upon the backs of so many of the engraved tablets of the celebrated triumph of Maximilian, and other works designed by Hans Burgmair, and recording the names of the individual wood-engravers who were employed to execute particular pieces of those extensive undertakings.

One hundred and thirty-five of the folio tablets of Maximilian's triumph are still preserved in the imperial library at Vienna, where an edition of them was struck off in the year 1796. According to Bartsch, they were engraved from the design (for the whole forms but one long procession) not of Albert Durer, as had formerly been supposed, but of Hans Burgmair, in 1516 and the three following years. The names of the different wood-engravers employed are written, says Mr. Bartsch, upon the backs of several of the blocks, in the following manner. Upon N^o 18. of the edition just mentioned, "Der kert an die Ellend. hat Wilhelm geschitten;" *i. e.* this block joins to that which represents the elks. It was engraved by William: and so of the rest.

The names or initials of engravers found upon the backs of these extraordinary tablets are seventeen in number, and are as follow: 1. Jerome André, surnamed Resch, or Rösch (one of the most eminent engravers of Nuremberg.) 2. Jan de Bonn. 3. Cornelius, (perhaps Cornelius de Bonn.) 4. Hans Frank. 5. Saint German. 6. Wilhelm. 7. Corneille Liefrink. 8. Wilhelm Liefrink. 9. Alexis Lindt. 10. Joffe de Negker. 11. Vincent Pfarkecher. 12. Jaques Rupp. 13. Hans Schaufelien. 14. Jan Taberith. 15. F. P. 16. A monogram, composed of H. F. 17. W. R.

The imperial library likewise possesses an hundred and twenty-two blocks, engraved from the designs of Burgmair, representing the saints, male and female, of the family of Maximilian. One hundred and nineteen of these were republished in the year 1799; and upon the backs of the blocks were found the names of the eight following engravers on wood; *viz.* 1. Hans Frank. 2. Corneille Liefrink. 3. Alexis Lindt. 4. Joffe de Negker. 5. Wolfgang Resch. 6. Hans Taberith. 7. Wilhelm Taberith. And, 8. Nicholas Seeman. Probably no writer who has entered upon a critical examination of these early works has been so well qualified to judge of them as Mr. Ottley: and that gentleman, while he admits that these inscriptions of names sufficiently prove that the great bulk of the numerous wood-cuts bearing the initials of Burgmair, were not cut upon the wooden blocks by his own hand; and that by parity of reasoning it might be fair to conclude the same of a large proportion of those bearing the monograms or initials of Durer, and other eminent designers; yet he can by no means persuade himself that the abilities of the ordinary wood-engravers, who abounded in Germany at the

close of the 15th century, could have been such as to render them in any material degree instrumental in bringing about that sudden and considerable improvement which took place in their art at that period. They had been accustomed to manufacture the barbarous wood-cuts used by the illuminists and venders of playing-cards, and were probably incapable of comprehending or appreciating those delicate, but free and masterly touches, which characterize the designs of a great and finished artist like Durer; and if so, wholly unqualified to represent them with any tolerable degree of fidelity. We may, therefore, readily believe that the numerous and flourishing school of wood-engravers, which we find spreading over Germany, and from thence to Italy, in the early part of the 16th century, owes its excellence to the great designers of that time; and especially to Albert Durer, who during his youth assiduously applied himself to the practice and improvement of the art, and afterward taught it to numerous pupils, who, already grounded in the principles of design, and working continually under the eye of their master, by degrees became qualified to assist him greatly in his numerous works of this kind. The intelligence, the delicacy, and the feeling, which we observe in the execution of most of the wood-cuts of Albert Durer, can only, Mr. Ottley thinks, be accounted for in this way; and the reader will probably admit that his opinion on the subject is not a little strengthened by the circumstance of Durer having been himself the publisher of all his chief works of this kind, more especially when added to the fact, that of the years 1509, 1510, and 1511, during which so large a proportion of his wood-engravings were executed, we have scarcely any thing by his hand engraved in copper.

The sudden and considerable improvement of which we have spoken, consisted of a superior style of execution, as well as of design. The meagre and miserable forms derived from the legends of superstition, and the Greek painters of the dark ages, began to give way to a clearer view of nature; and the few and scanty single-lined hatchings, which rather indicated than expressed shadow, were superseded by those bold courses of lines, as if hatched with a pen, and crossed with second and in some instances with third courses of lines, which Wolgemuth introduced, and Durer improved.

This mode of execution appeared to many persons so very difficult, and requiring so much more of pains and patient labour than they were warranted by other parts of these engravings in believing to have been bestowed on them, as to have excited considerable doubts whether the prints which contain these dark crossings were really impressed from wooden blocks. They were by some persons rather supposed to have been printed from casts, for which the engraved blocks served perhaps as matrixes; and a controversy hinging on this doubt has been for some time carried on by antiquarian inquirers, with sufficient boldness on both sides. The truth, however, could only remain with one party, and the subsequent production by Mr. Ottley, of some of the engraved blocks of wood themselves, either from the hands of Albert Durer, or those of his disciples, has proved that the dark crossings were actually delivered from wood, and settled the controversy, as far as respects that artist and his contemporaries, if not his successors.

The readers of our account of the German school of engraving, may have observed that ourselves were among the number of sceptics. As the truth was our object, we willingly confess our earlier mistake now that the fact is ascertained; and have too much respect for truth and the public to feel the least backwardness in recording it. Whether we

flatter ourselves that we can afford this record out of the flock of our reputation, is for our private feelings. If from our expression of doubt, research in the right direction, and satisfactory ascertainment, have resulted, our scepticism has not been in vain; nor have we been in vain anxious to tell what we believed, as well as what we knew. Respecting the dark cross-hatchings which so frequently occur in the works of Albert Durer, Mr. Ottley's argument is conclusive: yet there are two things in his book on engraving, for which we cannot award to him the same approbation; and these are, his discontinuing his history precisely at the same epoch where Mr. Landseer had been obliged to break off a course of (published) lectures that are confessedly imperfect; and his mis-stating both the words and meaning of that writer, in the only place where he professes to have quoted him.

We shall next proceed to describe the modes of workmanship, or execution, which have prevailed among the more modern practitioners of the art; beginning with that which is in use for the more common or ordinary purposes, and following with those refinements of the art which are practised only by its superior professors. Our account will be followed by some anecdotes and remarks relative to the earlier history of the art, which we hope will prove in no small degree worthy of the notice of the connoisseur and print-collector.

Before the artist begins his engraving, the surface of the block or tablet which is to receive it, must, by means of an instrument termed a *scraper*, succeeding to a fine watch-spring saw, be made level, and sufficiently smooth for the reception of the design which is intended to be represented. Should this design be very simple in its nature, such as a small geometrical diagram, for example, being previously drawn on paper either with a black-lead pencil, or Indian ink, it is sometimes laid on an engraver's sand-bag, or other such hard cushion, and the block being carefully placed over it, a smart blow struck on the back of the block with a broad-faced hammer, will transfer the lines from the paper to the wood, in a manner sufficiently plain and accurate for such purposes, when by means of the gravers, gouges, scrapers, &c. which have been before mentioned, the engraver begins his work of incisions and hollows, scooping away the whole surface of the block, except the diagram, or other simple design required.

In other cases, the design to be engraven is either traced by passing a blunted steel-point over the outlines, the back of the drawing being rubbed with powdered red-chalk, or is sketched out with a black-lead pencil, and the different shades washed in with Indian ink, in the same manner as a chiaro-scuro drawing on paper. This method is used in making drawings for cuts to be introduced in common and cheap publications, in which a bold shewy effect is chiefly required. In engraving such drawings made on the wood, the artist renders the several forms and tints by incisions cut in the block; and the principle on which he proceeds may be readily conceived by recollecting (what we have alluded to in an earlier part of this article), that were the block to be printed before the engraver commenced his operations, it would yield merely a black spot: every incision therefore made in the block will produce the impression of a white line or hatching, and thus afford the means of introducing any portion of light that may be required. By the multiplication of these white lines or hatchings, the engraver lightens the tint at his pleasure; and by the various widths, thicknesses, crossings, and intertextures of the incisions thus made in the wood, not only the forms and various gradations of shadow from light to darkness, but also the textures or
external

WOOD-ENGRAVING.




external characters of the various objects which may enter into the composition, may be very well represented.

Another mode of proceeding is occasionally resorted to in cases where engravings of a superior and more elaborate character are required, and which we have reason to believe was first practised in England by our countryman, Mr. John Thurston. In these cases, all the light and curious part of the design are hatched in, line by line, by the draftsman or designer himself, on the block, and which is performed either with a pen and Indian ink, after the manner of those ancient artists of the German school of whom we have treated, or else with the more modern and elegant instrument, a black-lead pencil. In some instances we have known the whole composition in all its details, both of light and obscurity, thus finished upon the wood in the most elaborate manner, before the engraver began his work of incision and scooping; but in most instances, the shadows and parts requiring less definition, and where the engraver may with more safety be left to the guidance of his own judgment, are merely washed in with a camel's-hair pencil and Indian ink, as in the foregoing method. Or else the designer uses a black-lead pencil, with which he rubs or scumbles in the less important tints. And the drawing on the wood being thus prepared, the engraver proceeds with the manual and linear portion of it, by cutting away the interstices between the pencilled or penned lines, as in the ancient manner, and the washed portion is treated in the modern method which we have described above.

Considerable skill on the part of the engraver is sometimes requisite in finishing the work, in order to unite and harmonize the whole, in which the designer's aid is not unfrequently required, who on a proof impression taken for the purpose hatches and works, with a fine camel's-hair pencil and white paint, over the dissonant parts, regulating at the same time the general effect, the drawing of the parts, and the style of execution. This touched-proof, viewed in the reversing glass, is carefully copied by the engraver on his block, which concludes the process.

There is, however, in the nature of things, no reason whatever why these two characters of engraver and designer may not exist united in the same individual; nor are the instances of such union unfrequent in fact. Mr. Bewick, of Newcastle,—whose highly-enriched volumes of engravings of birds and quadrupeds, adorned with delightful vignettes, are master-pieces of the art, and have merited and found a place in almost every library,—possesses, with his xylographic powers, a fund of exquisite humour, an originality of thought, and an accuracy of observation of the details of nature; together with an adequate talent of expressing those observations, which are really as surprising as they are diverting and instructive.

We believe that this artist, or his deceased brother, was the first who adopted an expedient which the present writer has been informed was originally suggested by Mr. Bulmer, proprietor of the Shakspeare printing-office,—that of lowering a little the surface of his engraving, by means of a very broad flat scraper, in those parts where tenderness and delicacy of impression were more peculiarly desirable; a thing trivial in itself, yet of sufficient importance in works that have pretensions to be regarded as highly finished, to have been subsequently imitated by most of the other engravers in wood. Among those who in modern times have united in themselves the characters of designers and wood-engravers, should also be mentioned Mr. Clennell, who has executed some of his own energetic compositions in a vigorous and masterly style, which few have been able to surpass.

Mr. Thurston,—more versed in all the technic varieties of linear practicability, and more accomplished in his academic powers of delineating the human form through all its gradations of action, character, and expression, than any of his predecessors in the xylographic art,—in his habits of thought and style of design, is poetical, didactic, profound, allegoric, recondite, ideal. Of the professors of imitative art, who have wisely employed their talent to a moral purpose, few have improved and delighted us so much, or caused us to reflect so variously or so deeply. But though Mr. Thurston has engraved very successfully on copper, we believe that he has always entrusted his designs on wood to be executed by others, (some of them latterly by a son of promising talents,) and from the black-lead drawings of this artist, performed on the blocks themselves, have been produced the best engravings of the London and Liverpool schools. We subjoin the names and monograms of the principal of those artists who have been engaged in their execution:—T. Clennell, C. Nesbit , R. Branston , J. Thompson , H. F. P. Hole, W. Hughes.

By the two latter of these we have seen landscape subjects of recent execution, which have excited in us no small degree of admiration of their professional powers. In a park-scene after Cuijt, engraved by Mr. Hughes, (who professes to have studied under Mr. Hole,) the trees more especially,—which have been generally and justly regarded as objects more difficult to express in this mode of art, than almost any other species of objects whatever,—are treated with a degree of looseness, freedom, and local knowledge of the characters of their various foliage, and modes of branching and ramification, that we believe is quite unprecedented, and much more resembling an etching on copper from the needle of Waterloo or Middiman, than any former production of the wood-engravers' art. And there has also very lately appeared a book, entitled "The Club," after the designs of Thurston, which is not less excellent in its way. It consists of twenty-four characteristic head-pieces of the several members of the club, a title-page representing the club collectively, beside various tail-piece vignettes, and impresses us with a depth of philosophical penetration into the human character in all its varieties both natural and assumed; for here the nicer physiognomical traits which mark the lesser discriminations between wit, humour, and ridicule, in their various modifications, are faithfully rendered: indeed with a degree of delicacy and fidelity which until now we had not conceived to lie within this province of art.

In wood-engravings, like the best of these modern productions which we have mentioned, there is more original feeling, more of the truth of nature, and the blandishments of art, than in all the dry, monkish, legendary rubbish put together, toward which the dealers in and writers on such rarities (who are frequently the same persons) are so very anxious to attract and retain the public attention, and which are so ardently sought after by the wooden and would-be connoisseurs of the day.

Some few connoisseurs there are, nevertheless, that with great sensibility to the beauties of meritorious works of this kind, collect also the early rarities of the art as curiosities, and as interesting steps in tracing the march of European xylography, from its rude outset towards its present attainments: but the idle occupation which so many expensive books have ridiculously promoted, the affected exquisiteness of regard for what is merely scarce, and which, if it were plentiful, would be justly esteemed as mere rubbish, can scarcely be too severely reprehended, when we observe that

by giving an erroneous direction to the public taste, it operates as the very bane of modern merit, and of all principled encouragement of the art.

A man who collects these early rarities, and these only, may be pretty certainly pronounced to be a person of no intrinsic relish for the productions of art, and by no remote analogy may be easily perceived to be in the predicament of Rochefoucault's man of gravity, who assumes a mysterious carriage of the body to cover the defects of the mind.

Between the territories of Error and Truth, there is no neutral ground; neither can be made to recede without the other's advancing. Among the causes that, concurrently with the above, have retarded the progress of the art of wood-engraving, indifferent and bad printing ought first and chiefly to be mentioned; for this evil is feverely felt by all modern designers and engravers on wood, (and, like most other evils, by far the most heavily by the best,) the delicate parts of whose most elaborate performances are so frequently marred by this operation.

The bad printing of wood-cuts generally proceeds from one or more of the following mistakes, to use the mildest term that occurs to us: Printers being unable of themselves to judge of the effect required in an impression; their being generally too much restricted in price by the publishing-book-sellers to afford the necessary attention, even were they better informed; the false respect exacted by opulence, which renders them too ignorantly proud to submit to the direction of artists, who are generally poorer men than themselves; with which cause, prejudice in favour of old methods of practice is always ready to unite itself; the practice of over-damping English, French, and even India paper. To which may be added the use of blanketing, and the neglecting to have the engravings properly made ready under the direction of the artist: all of which lead to the general corollary, or inference, that the engraver should always superintend the printing of his own works.

WOOD-ENGRAVING, *Origin and Ancient History of.* Father Du Halde adduces very satisfactory reasons for our believing that the art of engraving on wood existed and was practised in China for several centuries before its appearance in Europe. Whether it is of Chinese transplantation, or spontaneous European growth; whether it was introduced by the Venetian traders and travellers to India, or was re-invented, as the baron Heinekin supposes, in Germany, by the Briefmalers and Formschnieders, who fabricated playing-cards, and the miserable legends of monkish superstition; or whether it was not discovered, as Papillon has asserted, at Ravenna, as early as the year 1285; have been examined with great critical attention, and at least as much perseverance as the public will sympathize with, by the abbé Zani, Mr. Otley, and others. To the works respectively of the Italian abbé, and the English historian and connoisseur, we refer those who may be desirous of obtaining more local and detailed information concerning the early curiosities of the art than belongs to the plan of our Cyclopædia. The story of the two Cunio, which they have repeated at great length from Papillon, and illustrated by their own more profound knowledge of the subject, is romantic in the extreme: so much so, that the antiquarian interest which the reader may feel with us on the score of the curious wooden blocks from "the life of the great and magnanimous Macedonian king," merges in the chivalry and fine art, the poetic and pictorial fervour, and the tragic fate, of the twin brother and sister, the ancient pride of Ravenna, and of the illustrious house of Cunio.

Papillon relates, that when he was a young man, he "discovered an epoch of engraving prints and characters on wood, certainly much more ancient than any hitherto known in Europe;" and the story of his discovery is, that being employed about a century ago in papering a closet for a Swiss captain of the name of De Greder, in the village of Bagneux, near Mont-Rouge, the captain, finding he possessed a taste for such matters, shewed him two or three very ancient volumes, and they conversed together concerning the prints contained in them, and the antiquity of engraving on wood. Papillon proceeds to give the description of the principal, *i. e.* the most ancient, of these volumes, as follows:—Upon a cartouch, or frontispiece, decorated with fanciful ornaments, and measuring about nine inches in width by six in height, with, at the top of it, the armorial bearings no doubt of the family of Cunio, are rudely engraven the following words, in bad Latin, or ancient Gothic Italian, with many abbreviations, which were rendered and explained to him by M. de Greder.

"The heroic actions represented in figures, of the great and magnanimous Macedonian king, the bold and valiant Alexander; dedicated, presented, and humbly offered to the most holy father pope Honorius IV., the glory and support of the Church, and to our illustrious and generous father and mother, by us, Alessandro Alberico Cunio, cavaliere, and Isabella Cunio, twin brother and sister: first reduced, imagined, and attempted to be executed in relief, with a small knife, on blocks of wood, made even and polished by this learned and dear sister, continued and finished by us together, at Ravenna, from the eight pictures of our invention, painted six times larger than here represented; engraved, explained by verses, and thus marked upon the paper to perpetuate the number of them, and to enable us to present them to our relations and friends, in testimony of gratitude, friendship, and affection. All this was done and finished by us when only sixteen years of age."

The cartouch mentioned above is enclosed in a square formed by a simple black line, one-twelfth of an inch in thickness; a few light hatchings, irregularly placed, and executed without precision, indicate the shadows of the ornaments. "Immediately following this frontispiece (says Papillon) are the eight pictures, engraved in wood, of the same dimensions, and surrounded by a similar fillet: they have also a few faint hatchings, to indicate the shadows. At the bottom of each of these prints, between the broad line or fillet which bounds the subject, and another parallel line distant from it about the breadth of a finger, are four Latin verses engraved upon the block, which poetically explain the subject; and above each is its title. The impressions of all of them are of a grey tint, and spotty; as if the paper had not been damped or wetted before it was laid upon the engraved blocks. The figures, which are passable in respect to their outlines, although of a semi-gothic taste, are sufficiently well characterized and draped; one may perceive by them that in Italy the arts of design were then beginning by degrees to experience melioration. The names of the principal personages represented are engraved under their figures, as Alexander, Philip, Darius, Campaspe, and others."

Papillon next describes the eight engravings severally, which bear the names respectively of the twins Alexander and Isabel Cunio, and it would appear from his descriptions that Isabel was the superior artist of the two.

Upon the blank leaf which follows the last print, badly written in old Swiss characters, and with ink so pale as to be scarcely legible, is the following memorandum.

"This precious book was given to my grandfather, Jan. Jacq. Turine, a native of Berne, by the illustrious count di Cunio, magistrate (podesta) of Imola, who hon-

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noured him with his liberal friendship. Of all the books I possess, I esteem it the most, on account of the quarter from whence it came into our family; and on account of the science, the valour, the beauty of the amiable twins Cunio, and their noble and generous intention of thus gratifying their relatives and friends. Behold their singular and curious history in the manner in which it was several times related to me by my venerable father, and according to which I have caused it to be written more legibly than I myself could have done it." What follows is written in a better hand, and with blacker ink.

"The young and amiable Cunio, twin brother and sister, were the first children of the son of the count di Cunio, which he had by a noble and beautiful Veronese lady, allied to the family of pope Honorius IV., when he was only a cardinal. This young nobleman had espoused this young lady clandestinely, without the knowledge of the relations of either of them; who, when they discovered the affair by her pregnancy, caused the marriage to be annulled, and the priest who had married the two lovers to be banished. The noble lady, fearing equally the anger of her father and that of the count di Cunio, took refuge in the house of one of her aunts, where she was delivered of these twins. Nevertheless the count di Cunio, out of regard to his son, whom he obliged to espouse another noble lady, permitted him to bring up these children in his house, which was done with every instruction and tenderness possible, as well on the part of the count as on that of his son's wife, who conceived such an affection for Isabella Cunio, that she loved and cherished her as if she had been her own daughter; loving equally Alessandro Alberico Cunio her brother, who, like his sister, was full of talent, and of a most amiable disposition. Both of them made rapid advances in various sciences, profiting by the instruction of their masters; but especially Isabella, who, at thirteen years of age, was already considered as a prodigy; for she perfectly understood and wrote Latin, composed verses, had acquired a knowledge of geometry, was skilful in music, and played upon several instruments; moreover, she was practised in drawing, and painted with taste and delicacy. Her brother, urged on by emulation, endeavoured to equal her; often, however, acknowledging that he felt he could never attain to so high a degree of perfection. He himself was, nevertheless, one of the finest young men of Italy; he equalled his sister in beauty of person, and possessed great courage, elevation of soul, and an uncommon degree of facility in acquiring and perfecting himself in whatever he applied to. Both of them constituted the delight of their parents, and they loved each other so perfectly, that the pleasure or chagrin of the one or the other was divided between them. At fourteen years of age, this young gentleman could manage a horse, was practised in the use of arms, and in all exercises proper for a young man of quality; he also understood Latin, and had considerable skill in painting.

"His father having, in consequence of the troubles of Italy, taken up arms, was induced, by his repeated solicitations, to take him with him the same year, (*viz.* at the age of 14,) that under the eyes of his father he might make his first campaign. He was entrusted with the command of a squadron of twenty-five horse; with which, for his first essay, he attacked, routed, and put to flight, after a vigorous resistance, almost two hundred of the enemy; but his courage having carried him too far, he unexpectedly found himself surrounded by many of the fugitives; from whom, nevertheless, with a valour not to be equalled, he succeeded in disengaging himself, without sustaining any other injury than that of a wound in his left arm. His father, who had flown to his succour, found him returning with

one of the standards of the enemy, with which he had bound up his wound: he embraced him, full of delight at his glorious achievement, and at the same time, as his son's wound was not considerable, and as he was desirous to reward such great bravery upon the spot, he solemnly made him a knight, (*i. e.* a knight-banneret,) although he was already one by his birth; dubbing him in the same place where he had given such proofs of his extraordinary valour. The young man was so transported with joy at this honour conferred on him in the presence of the troops commanded by his father, (who, in consequence of the death of *his* father, which had recently happened, was now become the count di Cunio,) that, wounded as he was, he instantly demanded permission to go and see his mother, that he might inform her of the glory and of the honour which he had just acquired; which was granted by the count the more readily, as he was glad to have this opportunity of testifying to that noble and afflicted lady (who had always remained with her aunt a few miles from Ravenna) the love and esteem which he ever continued to entertain for her; of which he certainly would have given more solid proofs, by re-establishing their marriage, and publicly espousing her, had he not felt it his duty to cherish the wife his father had obliged him to marry, by whom he had several children.

"The young knight, therefore, immediately set out, escorted by the remains of his troop, out of which he had eight or ten men killed or wounded. With this equipage, and these attendants, who bore testimony to his valour wherever he passed, he arrived at the residence of his mother, with whom he staid two days; after which he repaired to Ravenna, to shew a similar mark of respect to the wife of his father, who was so charmed by his noble actions, as well as by his attentions towards her, that she herself led him by the hand to the apartment of the amiable Isabella, who, seeing him with his arm bound up, was at first alarmed. He remained a few days in that city; but impatient to return to his father, that he might have an opportunity of distinguishing himself by new exploits, he set off before his wound was yet healed. The count reprimanded him for not having sent back his troop, and for not remaining at Ravenna till he was cured, and would not permit him to serve again during the rest of the campaign: shortly after, when his arm was perfectly healed, he sent him home, saying to him pleasantly, that he did not choose to be outdone by him all the remaining time the troops would continue in action that year. It was soon after this that Isabella and he began to compose and execute the pictures of the actions of Alexander. He made a second campaign with his father, after which he again worked upon these pictures, conjointly with Isabella, who applied herself to reduce them, and to engrave them on blocks of wood. After they had finished and printed these pieces, and presented them to pope Honorius, and to their other relations and friends, the cavalier joined the army for the fourth time, accompanied by a young nobleman, one of his friends, called Pandulfo; who, enamoured of the lovely Isabella, was desirous to signalize himself, that he might become more worthy of her hand before he espoused her. But this last campaign was fatal to the cavalier Cunio: he fell, covered with wounds, by the side of his friend, who, whilst attempting to defend him, was also dangerously wounded. Isabella was so much affected by the death of her brother, which happened when he was not yet nineteen, that she determined never to marry: she languished and died, when she had scarcely completed her twentieth year. The death of this beautiful and learned young lady was followed by that of her lover, who had always hoped that his attentions and affections towards her would be rewarded by her consent at length to become his,

and

and also by that of her mother, who could not survive the loss of her beloved children. The count di Cunio, who had been deeply afflicted by the death of his son, could scarcely support that of his daughter. Even the countess di Cunio, who loved Isabella with great tenderness, fell ill of grief for her loss; and would have sunk under it, had she not been supported by the manly fortitude of the count. Happily the health of the countess was, by degrees, re-established. Some years afterwards, the generous count di Cunio gave this copy of the actions of Alexander, bound, as it now is, to my grandfather; and I have caused the leaves of paper to be inserted, upon which, by my orders, this history was written."

From the name of pope Honorius IV. being engraved on the frontispiece of these ancient prints, it is certain that this precious monument of the art of engraving on wood was executed between the years 1284 and 1286; because that pope governed the church only for the space of two years, ending in April 1287. The epoch, therefore, of this ancient specimen of engraving, is anterior to all the books printed in Europe that have been hitherto known. Papillon adds, that it is very probable that the copy of the work, which is recorded to have been presented to pope Honorius, may very possibly be preserved in the library of the Vatican.

The baron Heinnekin and our countryman Strutt distrust the truth of this story of the twins and their ancient work; but the latter has let escape that he read the original French with hasty inattention, and the former, after offering his objections, is compelled to add, "still there must be something true in Papillon's account; for, from my knowledge of his character, and his manner when I conversed with him, I am firmly persuaded that he did not invent that which he told me."

On the other hand, Zani confesses his entire belief of the account of Papillon, finding in it, as he states, "every mark of truth;" and Mr. Ottley conclusively adds, that "Papillon from his infancy had begun to collect materials for illustrating the history of his favourite art, of which, as is well known, he became a professor of some eminence, having been instructed in it by his father, who was also an engraver on wood. This practical experience combined with research could not but give him great advantages, and render him the less liable to be deceived in his decisions.

"His remarks, indeed, are those of a man well accustomed to examine ancient prints. The blocks, he says, appear to have been printed by means of the pressure or friction of the hand, with a light tint of Indigo in distemper; he describes the impressions to be granulous in some places, as if the paper had been applied to the engraved block without being first damped. Now, it is well known that many of the very early wood-prints were printed without any mixture of oil in the colours used for the purpose; and there is good reason also to believe that the paper was often applied in its dry state. The observations of Papillon are, therefore, not only evidence that he examined these prints with great attention, but that his eye was habituated to very nice discrimination, touching all those particulars which, perhaps, more than any others that could be named, are guides to enable us to judge of the antiquity of wood-engravings. And the probity of Papillon's character seems to preclude the idea that he had any intention to deceive."

The general corollaries resulting from these elaborate inquiries, which have been pursued to much greater length than we have chosen to follow, are, that the *origin of European wood-engraving* is unknown, (that is to say, that no person is acquainted with the precise facts of *who* first en-

graved on wood in this part of the world, or *when* it was done); and the reluctant acknowledgment that it cannot be shewn to be an European discovery at all.

Notwithstanding the detailed prolixity with which the chevalier Cunio's own account of his graphic enterprise is written, and though he states that himself and his sister invented the eight designs or pictures from which their tablets were engraven, he says nothing of the far more important fact, had it been so, of their having invented an art of multiplying those designs, so much more likely to have been announced by an ardent youth of sixteen, had there been the least foundation for such an announcement. No. He was too sincere: and he probably knew also that pope Honorius, and his noble relatives, were too well acquainted with similar processes employed by the Italian carvers, sealers, book-binders, and other artisans of Venice and Ravenna, (for the bindings of books were even then ornamented by means of heated iron stamps,) to have believed him, had he been less attentive to truth. He evidently regarded, and expected that his readers would regard, what he terms in one place engraving, and in another execution in relief with a small knife, as an expedient which might have been adopted by any other person in the existing state of that kind of knowledge, and which himself and sister practised—in all probability from the imperfect report of some inexperienced reporter, who might be their instructor in drawing.

At the period of which we are treating, Venice, as is well known, was the splendid emporium of exotic luxuries; and the reader will not hesitate to believe, that, with the facilities of Italian intercourse which then subsisted, much of the imported knowledge would travel at least to Ravenna, along with those foreign commodities and that commercial enterprise which were then spreading through Europe. The father and the uncle of Marco Polo, who had penetrated to Tartary and to China, returned from their nineteen years of travel in the East, in the same year in which the Cunio were born. Nothing, therefore, is more likely, under all the attendant circumstances, than that these travellers brought home the information necessary to the rude practice of the wood-engravers' art from *China*, which we are inclined to deem the parent country of wood-engraving, paper, and printing; and that it thus became known, though through what particular medium cannot now be traced, to the illustrious and romantic twins of Ravenna.

Should it be objected here, that Marco Polo has not noticed this art, in the account which he has left us of the marvels which he had witnessed in China; the answer is obvious. Marco did not himself travel thither until after the first return of his father and uncle, nor did his book appear until ten years after that of "the heroic actions of the great and magnanimous Macedonian king," when wood-engraving would seem to have been no marvel. Marco very wisely preferred instructing the public in matters with which they were not hitherto acquainted.

In corroboration of this account may be mentioned, that the manner in which the work of the Cunio is described to have been performed, is precisely that in which the Chinese have from time immemorial engraven on wood, and in which they still continue to practise that art, as may be seen by any person who may please to indulge himself in the curiosity of inspecting those engraved or carved tablets of wood which are preserved in the museum of the Honourable East India Company, in Leadenhall-street.

We have pursued this mixture of fact and probability thus far, because it appeared to us to contain the best evidence on the subject that is now obtainable; and because even this seems to render the uselessly-protracted and never-ending disputes, which have been so long kept up by certain interested

relled print-dealers and their prey, and their literary jackalls, about the superior pretensions of Italy or Germany to the discovery of this art; a mere recreation of idle credulity; a waiting of controversial ink and strength in strenuous idleness; an affair of spurious importance between "tweedle dum and tweedle dee."

If ridicule might find any other place in our Cyclopædia than under the letter R, we should here have recommended these rakers together of early German and Italian rubbish; these disciples of their rival pretensions; these admirers of the miserable virgins, and meagre faints and favours of those dark ages of art, which preceded the resurrection of the antique sculpture; these complimenting and catalogue-making worshippers of the pagods of tastelessness, who affect such an exquisite feeling for their wooden prodigies, to be consistent, and use their utmost diligence in seeking after the chips of the twins of Ravenna, or the still earlier chips of the wood-engravers of China, and to tell the tasteless and doting world of bibliographical cognoscenti, that these antique excisions are "graceful," or even more "elegant," than those which Cupid in shaving from his bow, in the celebrated picture by Corregio, in the collection of the most noble the marquis of Stafford.

In order to confer as much of factitious importance as might be found practicable on those relics of early European engraving and printing, for which these writers affect so great veneration; and to keep up the delusive idea that xylography and block-printing were *invented* here rather than *seen* elsewhere, the difference between change of form and change of colour in rendering impressions has been dwelt on with some emphasis: but nothing in the process of impressing stamps is of more frequent and ordinary occurrence, than for sufficient dirt to accumulate in an intaglio stamp that has lain by for any length of time, to produce a change of colour in the first impression yielded after such lapse of time. It must even have been a common, because obvious and efficient, mode of cleaning out the engraver's work. How frequently must this have occurred in sealing, for example. How frequently does it occur now: and here, without genius or meditation, is the link supplied at once in the chain of petty causes and effects, that has been so much magnified by the stupidity and tastelessness of modern dealers and collectors.

Of the impression of eight copies, mentioned by Papillon, of the life of Alexander, from the hands of the Cunio, it is not known that any remain; nor will this excite surprise, when we reflect that entire editions of some works that have been subsequently printed, have been swept from the face of day. The wood-engravings which succeeded these by the interesting twins of Ravenna, or were produced about the same period, appear to have been honestly thought of at the time; that is to say, thought of very little, because unworthy of being thought of much. From their non-importance, they have either all disappeared, or, from the same cause, not having been dated, the age of such of them as do remain, if any remain, is not known. The former of these is probably the chief reason of their disappearance; for who would think of seeking for the tops of ballads, or the dying speeches of criminals, or dirty playing-cards, which were printed even fifty years ago, or of preserving such things if accidentally found? and the early European wood-engravings of which we are treating, until Michael Wolgemuth arose, and introduced his better works of this kind into the Nuremberg Chronicle, were scarcely of more consequence than these lowest objects of the notice of the vulgar.

But though the prints have disappeared, a decree of the

senate of Venice remains to attest their former existence, and that "the art and mystery of making cards and printed figures had," in the year 1441, "fallen to total decay, and this in consequence of the great quantity of playing-cards and coloured figures printed, which are made out of Venice." The decree proceeds: "to which evil it is necessary to apply some remedy, in order that the said artists, who are a great many in family, may find encouragement rather than foreigners; let it be ordered and established," &c. &c.

This edict, as Mr. Ottley has well observed, speaks of "the art of making cards and printed figures in terms which would have been every way appropriate, had the edict had for its object the establishment of the oldest manufacture of Venice; and when coupled with other circumstances, especially the account of the two Cunio, furnishes a strong ground for the conjecture that engraving in wood had from a very early period been practised by the Venetians, who may easily be supposed to have learnt it in the course of their commerce with the Chinese."

The "printed figures," which are spoken of along with the playing-cards in the Venetian edict, were of the superstitious or devotional character to which we have already alluded, and which are described by Heinnekin as being soon afterward common in Germany and the Low Countries, when they were, — both the legendary wonders and the playing-cards, — designated by the same general term, and manufactured by the same hands; that is to say, cut in wood by the *Formschnieders*, and coloured afterward by the *Briefmalers*. And to this testimony of the German writer, the professor Fufeli adds, that "in the vulgar tongue of Zurich, and still more in that of the Roman Catholic cantons of Switzerland, *Helgen*, which is a corruption of *Heiligen*, meaning holy faints, is used to denote any historical print." The reason he gives for which is, "the first prints represented the figures of saints, or other devotional subjects, and were, on that account, termed *Helgen*; the term, in process of time, became generic, as others do, and is now used to denote prints of any kind, even those of profane subjects."

Of these superstitious excitements of the vulgar, the baron states, that he saw several which he believes to be of ancient date in the library of Wolfenbuttel. "These pieces," says he, "are of the same dimensions as our playing-cards: they measure three inches and a quarter in height, by two inches and a half in width." There are also in the same library, at the end of the book entitled "*Ars Moriendi*," five prints, in which are engraved divers figures of angels, devils, dying persons, faints, &c. similar to playing-cards, and of the same size, each figure being marked with a letter of the alphabet.

An engraved outline of a figure of this kind, of St. Bridget writing, with the Virgin and Child above, surrounded by a sort of cloud of Gothic scroll-work, and behind her a pilgrim's hat, wallet, and staff, Mr. Ottley has brought forward from the collection of earl Spencer. Perspective is grossly violated here, and it is of more than twice the dimensions of an ordinary playing-card; but this print, with another mentioned by M. Thierry as being in the library of the public Academy at Lyons, and which is said to be dated 1384, Mr. Ottley thinks may help to fill up the chasm between the work of the Cunio; and the larger print of St. Christopher crossing the water with the sacred Infant, which is dated 1423, is also in the collection of the same noble earl, and will be found mentioned in a more particular manner in the commencement of our account of the *GERMAN School of Engraving*.

WOODFORD, in *Geography*, a county of Kentucky, bordering on the Ohio, with 9171 inhabitants, of whom 3179 are slaves. Versailles is the chief town, containing 488 inhabitants, of whom 235 are slaves.—Also, a town of Vermont, east of Bennington, in the county of Bennington, with 254 inhabitants.

WOODGURRY, a town of Hindooftan, in Bednore; 35 miles N.E. of Simogu.

WOODIOUR, a town of Hindooftan, in Coimbetore; 10 miles N. of Darapuram.

WOODRIFF, a town of Tunis; 7 miles N.W. of Gabs.

WOODRUFF, SWEET, in *Agriculture*, a perennial plant, which is eat by different sorts of live-stock; and the aromatic flowers of which, when infused in water, excel in flavour, it is said, the finest teas.

WOODS, *Lake of the*, in *Geography*, a lake of North America, so called from the multiplicity of wood growing on its banks, such as oaks, pines, firs, &c. Its greatest length is about 70 miles, and greatest breadth forty. It contains but few islands, and those small. N. lat. 49°. W. long. 90°.

WOODS, a town of South Carolina; 32 miles W.N.W. of Georgetown.

WOODS'S Bay, a bay on the straits of Magellan; 15 miles W. of Cape Froward. S. lat. 53° 58'. W. long. 72° 55'.

WOODS'S Island, a small island near the north coast of Jamaica. N. lat. 18° 12'. W. long. 76° 8'.

WOODSAMADRUM, a town of Hindooftan, in Golconda; 12 miles S. of Damapetta.

WOODSBOROUGH, a post-town of Maryland; 75 miles N. of Washington.

WOODSIA, in *Botany*, owes its name to Mr. R. Brown, who dedicates this genus to the commemoration of Mr. Joseph Woods, F.L.S., an excellent British botanist. A valuable paper on the Roses of this country, about to appear in the Transactions of the Linnæan Society, will abundantly prove Mr. Woods' claims to such a distinction, even were it far less indiscriminately bestowed than usual.—Brown Tr. of Linn. Soc. v. 11. 170. Sm. Compend. Fl. Brit. ed. 2. 152. Pursh 660.—Class and order, *Cryptogamia Filices*. Nat. Ord. *Filices dorsales*.

Gen. Ch. *Frustrification* in roundish groups, on the back of the leaf. *Involucrum* cup-like, open, small, nearly flat, jagged, fringed with awl-shaped, incurved, jointed hairs. *Capsules* several, obovate, on short stalks, crowded, in the centre of the involucre, each bound by a vertical, jointed, elastic ring, and bursting irregularly at one side. *Seeds* numerous, kidney-shaped, granulated, extremely minute.

Eff. Ch. Groups of capsules scattered, roundish, each seated on a capillary-fringed involucre.

Obs. We gladly here adopt the term *group*, as technically synonymous with *SORUS*, (see that article,) instead of dot, spot, or line, which are liable to much exception.

1. *W. ilvensis*. Long-leaved Woodfia. Br. n. 1. Pursh n. 2. (*Acrostichum ilvense*; Linn. Sp. 1528. Fl. Dan. t. 391. *Polypodium ilvense*; Swartz Syn. Fil. 39. Willd. Sp. Pl. v. 5. 198. "Schkuhr Crypt. 16. t. 19." *Nephrodium lanosum*; Michaux Boreal.-Amer. v. 2. 270. *Lonchitis aspera ilvensis*; Dalech. Hist. 1221. f. 3.)—Fronn pinnate; leaflets lanceolate, deeply pinnatifid, with numerous, nearly uniform, oblong lobes. This appears to have been first discovered in the Mediterranean isle of Ilva, whence the specific name, which is very exceptionable, the same species being found on rocks in the north of Europe, as well as in North America, from Canada to Virginia. We have American specimens from Mr. Francis Boott,

agreeing exactly with Siberian ones in the Linnæan herbarium. We know not of this species having been detected in Britain. The fronds, five or six inches high, grow erect, in dense tufts. Their stalks, not quite half that height, are brown, bearing, like the mid-rib of each principal leaflet, many strap-shaped, taper-pointed, membranous scales. The frond itself is oblong, or lanceolate, composed of twelve or more pairs of oblong lanceolate leaflets, or pinnae, opposite or alternate, each about an inch long, numerous pinnatifid; their lower segments wavy, nearly equal and uniform; upper confluent: their upper surface is even, nearly smooth, of a fine green; lower covered with pale brown scales, and crowded hairy groups of capsules.

2. *W. hyperborea*. Round-leaved Woodfia. Brown n. 2. t. 11. Pursh n. 1. Sm. Compend. 158. (*Acrostichum hyperboreum*; Liljebblad in Stockh. Trans. for 1793. 201. t. 8. *A. alpinum*; Bolt. Fil. Brit. 76. t. 42. *Polypodium hyperboreum*; Swartz Syn. Fil. 39. Willd. Sp. Pl. v. 5. 195. Sm. Engl. Bot. t. 2023. *P. arvonicum*; Fl. Brit. 1115. *P. ilvense*; With. 774. *Filicula pumila*, *Lonchitidis Marantæ* species *Cambrobritannica*; Pluk. Phyt. t. 89. f. 5.)—Fronn pinnate; leaflets heart-shaped, rounded, pinnatifid, lobes rounded, waved, unequal.—Native of alpine rocks, chiefly in the northern parts of Europe. It occurs, though rarely, on the highest summits of the Welsh and Scottish mountains. A smaller plant than the preceding, often not above an inch high, though generally about three inches. The leaflets are shorter, and more rounded, as well as their lobes; of a thinner texture; much less deeply pinnatifid, except at their base, where the bottom pair of lobes are often so deeply separated, as to form two little leaflets, wavy, or obscurely lobed, and sometimes of unequal size. The main stalk is scaly; leaflets hairy on both sides.

We readily agree with Mr. Brown, that some intermediate varieties of each species render the specific characters of both considerably difficult. Yet there seems no reason to doubt their being distinct plants. Mr. Bauer's delineation of this fern, in the Linnæan Transactions, excellently engraved by Warner, is one of the finest illustrations of a natural production that can any where be seen.

WOODSTOCK, (New,) in *Geography*, a borough and market-town in the hundred of Wootton, and county of Oxford, England, is situated 8 miles N.N.W. from Oxford, and 62½ W.N.W. from London. It has a market on Tuesday, and fairs on the 5th of April, Tuesday in Whitsun-week, 2d of August, 2d of October, Tuesday after the 1st of November, and 17th of December. The town sends two representatives to parliament, the mayor being the returning officer. The corporation consists of a mayor, a high-steward, a recorder, town-clerk, four aldermen, and sixteen common-council men. In 1811, the houses in Woodstock were 235, and the inhabitants 1540. The south part of the present church is a fragment of an ancient chapel; but the northern face and the tower were erected in 1785. Adjoining to the church is a grammar-school, founded in 1585 by Mr. Cornwell, a native of the place; and near the southern entrance of the town is a range of alms-houses, erected in 1793 by the dukes of Marlborough, for six poor widows. The town-hall, a stone building, has under it the market-place, and was erected in 1766, from a design of sir William Chambers, at the expence of the late duke of Marlborough. The principal manufactures of the town are those of gloves and of polished steel. Various articles of this steel have been executed with great delicacy, and sold at high prices. This manufacture was introduced into Woodstock at the beginning of the last century; but it

it has much declined, on account of the cheapness of the cutlery goods furnished by Birmingham and Sheffield. The glove-manufacture is of later date; but has increased in the present day so much, that from 300 to 400 pairs of gloves are made weekly in the town and the neighbouring villages, and thus afford employment for about 1400 women and girls, and 70 men. Old Woodstock, of which only one mansion and a few irregular houses remain, stood in a sheltered situation on the little river Glyme, which supplies the magnificent piece of water in Blenheim-park. The manor-house, or royal palace, on the N. bank of the deep valley of the Glyme, within the bounds of the park, was the residence of Fair Rosamond, whose romantic adventures are deeply interwoven with the history of Henry II.; but the building has long disappeared. In this palace, that king, in 1164, received the homage of Malcolm, king of Scotland, and Rice, prince of Wales. In 1275 Edward I. held a parliament at Woodstock, and there was born his second son, Edmund, as was also the renowned Black Prince. Woodstock was inhabited occasionally by Richard II., and there Henry III. narrowly escaped assassination by a fanatic priest: an attempt was there also made by Morisco on the life of Henry VIII. The old palace was afterwards employed as a prison for Elizabeth, his daughter. In the time of the civil wars it suffered severely from the parliament's party; and about a century ago the gate-house, the last fragment of the edifice, was pulled down. But Woodstock is most worthy of note for having produced Chaucer, who was born there about 1328. The house in which he afterwards resided, while the court was in the palace, stood at the W. end of the town, near the usual entrance into Blenheim-park. Some relics of this building are still pointed out.

The great object of attraction at Woodstock is the magnificent palace of Blenheim, with the surrounding grounds, water, and park. The honour and estates of Woodstock, long belonging to the crown, were in 1705 conveyed by queen Anne, on the address of the house of commons, to the illustrious John, duke of Marlborough, to preserve the memory of his eminent services as a warrior and a statesman; particularly for the signal victory obtained by him, and prince Eugene of Savoy, at Blenheim, in Germany, over the French and Bavarians, on the 2d of August 1704. The house was erected by sir John Vanbrugh, at a convenient distance from the S. brink of a deep dell, in which ran the Glyme. The general distribution of this superb structure consists of a central mass of building, inclosing two small courts, and connected by colonnaded wings to two spacious quadrangles, forming the grand court of entrance. The centre is ornamented with a Corinthian portico, surmounted by a pediment and military emblems. The wings are crowned with towers serving at once to contain the chimneys, and to contribute to the picturesque grandeur of the edifice. The garden-front, extending from E. to W. 348 feet, is grand and magnificent. The interior of the mansion contains many noble apartments, adorned with paintings of eminent masters; particularly with a series of mythological pictures from the admirable pencil of Titian, presented to the first duke of Marlborough by the king of Sardinia, and with portraits of many eminent characters by the best artists. The library, occupying the whole of the W. front, 183 feet long and nearly 32 wide, is a magnificent room, originally destined to be a picture-gallery, but afterwards furnished with the grand Sunderland collection of books, containing upwards of 17,000 volumes. At one end is a marble statue of queen Anne by Rysbrack. In the W. wing is the chapel appropriately fitted up, and containing a monument, by the same sculptor, of the first duke, his

duchess, and their two sons, who died young. In the E. quadrangle of offices is the theatre, originally a green-house, calculated to accommodate 200 spectators. Near the E. angle of the mansion an observatory was erected by the late duke of Marlborough, and provided with a complete apparatus for astronomical observations by Ramsden; a grand telescope by Herschel was presented to the duke by his majesty, after his visit to Blenheim in 1786. The state-approach to the palace is by a straight avenue from the N. extremity of the park, over the river, by a bridge of one spacious and two smaller arches. Flowing in a deep dell, the small stream is made to assume the appearance of a naturally-winding river, expanding below the bridge into a broad irregular lake; thus, with the bridge, according with the grandeur of the palace and the noble extent of the park. A lofty column is erected in the midst of the great avenue, surmounted by a statue of the great duke, and charged on the pedestal with inscriptions stating his services and rewards. In the N.W. part of the park of Blenheim, vestiges may be traced of the ancient road, Akeman-street. Nearly two miles W. from the park is the village of Stonefield, at which place was discovered, in 1711, a tessellated pavement 35 feet by 20, representing, among other figures, a Bacchus, with his thyrsus and cup, mounted on a tyger. In addition to this curious antique, in 1779 were discovered, near the same spot, the areas of a number of other apartments paved in the same manner; and adjoining were the remains of a bath with its hypocaust: Roman coins from Vespasian downwards were found on the same spot. A plan and some account of these remains have been published by Henry Hakewill, esq. architect.—*Beauties of England and Wales, Oxfordshire*, by J. N. Brewer, 8vo. 1811. The *Blenheim Guide*, by Dr. Mason, 12mo. 1817. *Havell's Views of Seats* include two fine Engravings of Blenheim Palace, and a critical Account of the House, Scenery, &c. folio, 1818.

WOODSTOCK, a town of the state of Connecticut, in the county of Windham, with 2654 inhabitants; 57 miles S.W. of Boston.—Also, a town of North Carolina, on the left bank of Pamlico river; 22 miles N.N.E. of Newbern.—Also, a post-town of Virginia; 112 miles W. of Washington.—Also, a post-town of Vermont, in the county of Windsor, with 2672 inhabitants; 5 miles N.W. of Windsor.—Also, a township of New York; 46 miles S. of Albany.—Also, a post-town of New Jersey; 26 miles S.S.W. of Philadelphia.

WOODVILLE, WILLIAM, M.D. in *Biography*, was born at Cockermonth, in the year 1752. Having received a good classical education in his native town, he was placed with a respectable apothecary, to whom he served a short apprenticeship. He afterwards proceeded to Edinburgh, where, after the usual residence, he obtained, in 1775, the degree of M.D., having written and defended a very ingenious thesis "De irritabilitate fibrarum motricium." After passing some time on the continent, he returned and settled near his native place, where he practised his profession five or six years. Dr. Woodville then came to London, and was soon appointed one of the physicians to the Middlesex Dispensary, the duties of which office he discharged in an exemplary manner. In 1790 he published the first part, which was afterwards completed in four quarto volumes, of a highly valuable work, intitled "Medical Botany." In 1791 he was elected physician to the Smallpox Hospital, in the room of the late Dr. Archer; and it may truly be said, that no man ever devoted, more conscientiously or zealously, time and great talents, to the promotion of an object, than did Dr. Woodville to improvement in the medical treatment of the patients, as well as in

the general government of the establishment. To the officers of the hospital, and those governors who took most interest in its welfare, his merits were well known; and some of the fruits of his genius and industry are before the public in a volume which was published in 1796, intitled "The History of the Small-pox in Great Britain, &c." This work, which it was the author's design to occupy two volumes in 8vo., was well conceived, including a brief history of the disease, and a review of all the publications on the subject of inoculation, with an experimental inquiry into the relative advantages of the various measures that had been recommended. Only the first volume of this work, which is well written, and contains much valuable information, was published, the happy discovery of the efficacy of vaccination having, in the author's opinion, superseded the necessity of the second appearing. Dr. Jenner's grand discovery made a due impression on the mind of Woodville; and as no other man had equal opportunities of witnessing and lamenting the ravages of the small-pox, so no person could be more sincerely anxious and active in the adoption of those means that were found adequate to guard mankind against that pestilence. It is very true, that on the subject of vaccination he was, like every body else, at first sceptical; but he suffered no opportunity to be lost of ascertaining its efficacy, and then of proclaiming his belief in it. Unhappily, in some of his early experiments an error was committed; he was not aware of the influence of the variolous atmosphere of the hospital. The result was, that in certain instances, either pure small-pox matter, or a deteriorated vaccine lymph, had been inserted into the arms of some patients. The effects were faithfully detailed; but being so different from those that had been described by Dr. Jenner, that excellent man and benefactor to the human race visited Dr. Woodville, with whom he argued and remonstrated on the subject. It is to be regretted that some asperities of remark took place between them, although both were equally and honourably engaged in the development of truth. The discussion, however, as is always the case, proved very useful in the dissemination of the new practice; and if Dr. Jenner had reason to find fault with the result of Dr. Woodville's early proceedings, he must have been abundantly gratified by his subsequent experiments and publications. The ample field in which Woodville was placed enabled him to vaccinate great multitudes, some thousands of whom he afterwards tested by variolous inoculation, and thus gave that publicity to vaccination, and that confidence in it, which it could not otherwise have attained in the course of many years. He was also ardently engaged in the inquiry into the nature and origin of the vaccine lymph; and, at his request, the writer of this short article three times inoculated him with fresh grease from the heel of a diseased horse. If in the heat and bitterness of contention men seek an apology for unguarded expressions and assertions, this cannot be granted to those who calumniate the dead; and therefore the statement in a late history of vaccination of Dr. Woodville having fallen a victim to the drinking of ardent spirits, is deserving of reprobation. Dr. Woodville cultivated the society of his professional brethren, by whom, on account of his talents and companionable qualities, he was held in high estimation; and one of those who enjoyed the intimacy of his friendship, from the period of his settling in London until the day of his death, contradicts the above unfounded calumny. His disease, which terminated in dropsy, had made such gradual advances during the last year of his life, that he frequently talked of his death, which no man ever contemplated with greater equanimity, as likely to take place about a certain assigned period.

He died at the hospital on the 26th of March 1805; and

on the 3d of April, a warm and just eulogium was pronounced over the body in the saloon by his friend Mr. Highmore. His parents having been Quakers, he by his own desire was interred in the Friends' burial-ground in Bunhill-fields, after a very appropriate address at the grave by Mrs. Pryor.

The editor is indebted for the preceding article to his much-esteemed friend J. Norris, etq., no less distinguished by his mental and moral qualities than by judgment and extent of reputation in his profession.

WOODVILLE, in *Geography*, a post-town of Virginia; 94 miles W. of Washington.

WOODWARD, JOHN, in *Biography*, was born in Derbyshire in 1664, and, being intended for trade, was apprenticed in London; but in a little while abandoned the shop for the sake of scientific pursuits. In 1687 Dr. Barwick took him into his family, and for the space of four years gave him instruction in medicine and anatomy. He then recommended him to the medical professorship in Gresham college, to which he was elected in 1692. Having directed his particular attention to fossils, with a view to which he had travelled through many districts of England, he published in 1695 "An Essay towards a Natural History of the Earth and terrestrial Bodies, especially Minerals; as also of the Sea, Rivers, and Springs; with an Account of the Universal Deluge, and of the Effects that it had upon the Earth," 8vo. His preparatory knowledge for a work of this kind was very slight, and therefore the execution of it was attacked by Dr. Martin Lister, and others. However, in the imperfect state of geology at that time, his performance engaged notice, and he was chosen in 1693 a fellow of the Royal Society. At this time he was in possession of an ancient iron shield, in the concavity of which was a sculpture representing the story of Camillus and the Gauls at Rome; and as it was a great curiosity among the learned, Dodwell gave an account of it in a Latin treatise, entitled "De Parma equestri Woodwardiana Differtatio." By this circumstance Woodward was led to increase his acquaintance with a certain class of literati, though he did not escape the ridicule of the wits. In 1695 he was created M.D. by archbishop Tenison, and in 1696 he obtained the same degree from Cambridge; and thus honoured, he was prepared for an admission into the College of Physicians as a fellow in 1702. But pursuing his inquiries into natural history and antiquities, he published some pieces in these departments: *viz.* "Some Thoughts and Experiments concerning Vegetation," communicated to the Royal Society, and printed in the Philosophical Transactions for 1669; "Naturalis Historia Telluris illustrata et aucta: accedit Methodica Fossilium in Classes Distributio," 1714, intended as a grand reply to those who objected to his Natural History of the Earth, which had been translated into Latin by Scheuchzer at Zurich; and "An Account of some Roman Urns, and other Antiquities, lately digged up near Bishopsgate; with brief Reflections upon the ancient and present State of London: in a Letter to Sir Christopher Wren." In his medical capacity, he published in 1718 "The State of Physic and of Diseases, &c." 8vo., in which he advanced the notion, that the bile and its salts, re-absorbed into the blood, were the true cause of life and animal motions, and that the same fermenting in the stomach were the cause of diseases; whence he was led to conclude that emetics to evacuate the morbid bile, and oily and unguinous medicines to correct it, were universal remedies. This publication produced a controversy with Dr. Freind, in which Woodward was answered both ludicrously and seriously, so that he gained little credit by his medical theory or practice. His chagrin, however, was diverted by the study of fossils, and the augmentation of his cabinet of specimens.

specimens. He soon after fell into a decline, which terminated his life in his apartments at Gresham college in 1727, at the age of 63. He bequeathed his personal property to the university of Cambridge, for the endowment of an annual lectureship, on a subject taken from his own writings in natural history or physic. Soon after his death were published an English edition of his "Method of Fossils," with various additions; and "A Catalogue of Fossils in the Collection of J. Woodward, M.D.," in 2 tomes, 8vo., a work of permanent estimation among geologists. In 1737 Dr. Templeman published Woodward's "Select Cases and Consultations in Physic," in which some valuable observations are interspersed. One of his hypotheses was, that the life resides in the blood, and in the separate parts of the body, not in the nerves; in confirmation of which he made many experiments, establishing the *vis insita* of muscles. Biog. Brit. Haller. Gen. Biog.

WOODWARD, an officer of the forest, whose function it is to look after the woods, and observe any offences either in vert, or venison, committed within his charge; and to prevent the same; and in case any deer are found killed, or hurt, to inform the verderor thereof, and present the delinquents at the next court of the forest.

Woodwards may not walk with bows and shafts, but with forest-bills. *Arcum et calamos gestare in foresta non licet, sed (ut rescripti utar verbo) hactenus tantummodo.* Term. Hil. an. 13 Ed. III.

WOODWARDIA, in *Botany*, a very fine and well-marked genus of ferns, dedicated by the writer of this article to the honour of his long and highly-valued friend, and botanical companion, Thomas Jenkinson Woodward, esq., LL.B., F.L.S., one of the best English botanists, whose skill and accuracy are only equalled by his liberality and zeal in the service of science. Mr. Woodward's name is well known as the important assistant of Dr. Withering in his national *Flora* (see WITHERINGIA), as well as by his communications to the Linnaean Society; amongst which, an essay on the *British Fuci*, written in conjunction with the present learned bishop of Carlisle, and printed in the third volume of that Society's Transactions, stands conspicuous.—Sm. Mem. de l'Acad. de Turin, v. 5. 411. t. 9. f. 3. Traçts 238. t. 1. f. 3. Willd. Sp. Pl. v. 5. 416. Swartz Syn. Fil. 116. Sprengel Crypt. Engl. ed. 131. t. 4. f. 29. Ait. Hort. Kew. v. 5. 523. Pursh 669.—Class and order, *Cryptogonia Filices*; sect. *annulatae*. Nat. Ord. *Filices dorsiferae*.

Eff. Cl. Groups of capsules oblong, distinct, straight, ranged in a simple row, in bordered cavities, parallel to each side of the rib. Involucrum superficial, vaulted, separating towards the rib.

Obs. Mr. Brown has separated from this genus, by the name of *Doodia*, Prodr. Nov. Holl. v. 1. 151, such species as have a flat *involucrum*, unconnected at its inner margin, and originating from an interbranching, or connecting, vein, at its opposite side. In these the *capsules* are not sunk into any bordered cavity, nor are the *groups*, with their *involucra*, so turgid, or prominent. *Woodwardia caudata*, Cavan. Leccion. 264. Swartz Syn. Fil. n. 2. Willd. n. 2, belongs to this genus of *Doodia*; and Mr. Brown defines two others, *aspera* and *media*, as likewise natives of New Holland, in which country, it seems, no true *Woodwardia* has been found.

1. *W. angustifolia*. Narrow-leaved Woodwardia. Sm. n. 1. Swartz n. 1. ("W. floridana; Schkuhr Crypt. 103. t. 111.") *W. onocleoides*; Willd. n. 1. Pursh n. 1. *Onoclea nodulosa*; Michaux Boreal.-Amer. v. 2. 272. Swartz Syn. Fil. 111. *Acrostichum areolatum*; Linn.

Sp. 1526. A. n. 12; Linn. Am. Acad. 274. *Osmunda caroliniana*; Walt. Carol. 257. *Lonchitis major virginiana*, folio vario, alis Polypodii in modum conjunctis; Morif. sect. 14. t. 2. f. 24. *Filix floridana*, prælongis et angustis pinnulis, &c.; Pluk. Amalth. t. 399. f. 1.)—Frons pinnate; leaflets linear, acute, entire; the barren ones finely serrated.—In cedar and cypress swamps, from New Jersey to Florida, fructifying in August. Perennial, about a foot high. *Pursh*. The root is creeping, scaly and shaggy, bearing several stalked, upright, smooth fronds, of a lanceolate figure, with a long taper point: the barren ones consisting entirely of lanceolate, acute, finely serrated leaflets, decurrent at their base, and somewhat confluent: the fertile of rather fewer, more distant, longer and narrower ones, likewise slightly decurrent and confluent at their base, each leaflet being nearly covered at the back, on each side of the rib, with a close series of turgid, nearly cylindrical, groups, a quarter of an inch long, of numerous capsules, every group closely covered by its own convex *involucrum*. Each group is encompassed with a considerably elevated uninterrupted line, bordering the hollow in which it lies. Willdenow has most unadvisedly changed the established specific name, without any right or pretence, surely for the worse rather than the better.

2. *W. japonica*. Blunt-lobed Japan Woodwardia. Sm. n. 2. Swartz n. 3. Willd. n. 3. Sprengel as above, f. 29. (*Blechnum japonicum*; Thunb. Jap. 333. t. 35. Linn. Suppl. 445.)—Frons pinnate; leaflets sessile, half pinnatifid, with close, obtuse, serrated lobes. Rows of fructification extremely close and crowded.—Gathered by Thunberg near Nagasaki, and in other parts of Japan, fructifying in June. Frond two feet, or more, in height. Stalk roughish, and somewhat scaly, not smooth. Leaflets five or six inches long, pointed, quite sessile, scaly at the base, each divided about half way to its rib into twelve pair, or more, of broad, bluntish, rounded, serrated lobes, above an inch long, and half an inch broad, quite close and parallel at the sides; paler beneath. Groups oblong, three or four in a continued line, close to the rib on each side. The *involucrum* reflexed to one side, after the capsules are fallen, leaves the cavity exposed, and like a box with its lid. The capsules appear all to be inserted into that margin of the cavity to which the *involucrum*, or lid, is attached.

3. *W. orientalis*. Sharp-lobed Japan Woodwardia. Swartz n. 4. also p. 315. Willd. n. 4. ("Blechnum radicans; Houtt. N. Hist. v. 2. t. 97. f. 1.")—Frons pinnate; leaflets stalked, deeply pinnatifid, with spreading, acute, serrated lobes. Rows of fructification close. Involucrum somewhat crescent-shaped.—Gathered by Thunberg in Japan. Very distinct from the last, as well as from *W. radicans*. The frond is more coriaceous than either, and seems to be rather glaucous. Stalk smooth and naked, at least in its upper part. Leaflets the size of the last, but tapering at their base into a short stalk; their segments considerably distant from each other, except at the very base, and somewhat revolute; sharply serrated, particularly at the point. Groups slightly lunate outwards, especially the upper and shorter ones, about seven in each row, crowded, and close to the rib. Perhaps it was from a specimen of this, confounded with the preceding, that Professor Thunberg described the main stalk as altogether smooth, and zigzag.

4. *W. virginica*. Virginian Woodwardia. Sm. n. 3. Swartz n. 7. Willd. n. 6. Ait. n. 2. Pursh n. 2. (*W. Banisteriana*; Michaux Boreal.-Amer. v. 2. 263. Swartz n. 8. *Blechnum virginicum*; Linn. Mant. 307. *Filix mas*, vulgari similis, pinnulis amplioribus planis, nec crenatis,

crenatis, virginiana; Pluk. Almag. 151. Phyt. t. 179. f. 2.)—Fronde pinnate; leaflets sessile, deeply pinnatifid, with spreading, obtuse, slightly crenate lobes. Rows of fructification accompanying their mid-rib as well as the ribs of the lobes.—In the swamps and shady woods of Virginia and Carolina. *Pursh*. We received it from Kew garden in 1785. The fructification is perfected in July and August. The frond is eighteen inches, or more, in height, with a pale smooth stalk. Leaflets alternate, above a finger's length, and about an inch, or more, in width, bright green, smooth; their numerous segments spreading moderately from each other, forming an acute angle at the base; their margin is somewhat revolute, and very obscurely crenate. Fructification most abundant on the leaflets of the upper half of the frond, forming lines all along their principal rib, at each side, as well as along the rib of each segment; the groups finally confluent. The depressions in which the groups are seated are very slight, though not imperceptible, and the involucre of each is narrower, less vaulted, and sooner turned aside, than in any other species with which we are acquainted, so that the present plant is in some measure intermediate between *Woodwardia* and *Doodia*. Perhaps it may prove these two genera not to be distinct, but while they remain so, we concur with Mr. Brown in keeping this species where it is. Plukenet's figure was drawn by Mr. Banister, the original discoverer of this fern.

5. *W. thelypteroides*. Small Woodwardia. *Pursh* n. 3.—“Fronde pinnate; leaflets sessile, linear-lanceolate, pinnatifid; villous at the base: segments of the barren ones oblong and bluntish; of the fertile ones shortened, triangular, and acute; all entire. Stalk downy, angular.”—In sandy swamps of South Carolina, near Charlestown, fructifying in July. Resembles the preceding, but is not half the size. *Pursh*.

6. *W. fimbriata*. Fringed Woodwardia.—Fronde pinnate; leaflets sessile, deeply pinnatifid, with spreading, rather acute, lobes, fringed with sharp teeth.—Gathered by Mr. Menzies, on the west coast of North America. This is larger in every part than *W. virginica*, and distinguished from that species by its more acute segments, whose margin is very conspicuously and copiously fringed with prickly teeth, directed towards the point. Groups of capsules large and turgid, ranged, a little obliquely, along the ribs of the segments, from three to five pair on each segment, none at the mid-rib of the leaflet itself. Involucre strongly and permanently vaulted. The bottom lobe of each leaflet, at the lower side, is shortened, dilated, and half heart-shaped, as is more rarely the case in *W. virginica*. Several of the upper leaflets are decurrent and confluent; the top ones undivided, and barren.

7. *W. radicans*. Rooting-stalked Woodwardia. Sm. n. 4. Swartz n. 5. Willd. n. 5. Ait. n. 1. “Schkuhr Crypt. 104. t. 112.” (Blechnum radicans; Linn. Mant. 307, excluding the reference to Plukenet, see *W. virginica*. Filix italica non ramosa maxima glabra, polypodii folio, gallas ferens, D. Micheli; Till. Pfl. 62. t. 24.)

β. *W. flans*. Swartz n. 6. “Schkuhr Crypt. 104. t. 113.” Willd.—Fronde pinnate; leaflets nearly sessile, deeply pinnatifid, with parallel, taper-pointed, sharply serrated lobes.—Native of deep clayey fissures of rocks in Madeira, according to Koenig. Found also in Italy and Portugal. A hardy greenhouse plant in England, and one of the most handsome of its tribe. The fronds are two or three feet high, and a foot and a half or near two feet in breadth, of a fine green, smooth, beautifully reticulated with veins, each main stalk producing at the back, near the top, a round scaly bud, or bulb, the origin of a young

plant. Leaflets generally alternate, often a span long, somewhat pectinate, with a long very slender point; their numerous segments more or less crowded, slightly curved, lanceolate, minutely and sharply serrated, each tapering to a sharp elongated point. Groups of capsules about seven pair on each segment, (none at the mid-rib of the leaflet,) close, direct, scarcely ever at all divaricated, turgid, pale brown, the cavities in which they lie very neatly and conspicuously bordered: uppermost leaflets simple and confluent, as in the foregoing species. We know not how the *W. flans*, which Cavanilles seems, by Swartz's work, to have first noticed, is supposed to differ from the *radicans*; but Willdenow asserts, on a comparison of numerous specimens, from different countries, that there is no specific distinction between them.

8. *W. dispar*. Various-leaved Woodwardia. Willd. n. 7. (Filix latifolia, pinnulis ferè acuminatis, dentata; Plum. Fil. 13. t. 16.)—Fronde pinnate; leaflets sessile, lanceolate, pointed, pinnatifid, with elliptic-lanceolate, entire lobes. Fructification crowded on the much smaller lobes, of a separate narrower frond.—Found by Plumier in Martinico. Willdenow appears to have adopted this species entirely from Plumier, a hazardous measure, as its genus can only be guessed from analogy. The barren fronds approach the last species in size, but their segments are shorter, entire, rather obtuse, and by no means taper-pointed. Those fronds which bear fruit have leaflets similar in shape and lobes to the others, but about one-third as large, at most, bearing a simple crowded row of fructification close to the rib of each segment. The groups of capsules are somewhat elliptical, and there is nothing adverse to the generic character of a *Woodwardia*; but, on the other hand, there is no particular indication of that character.

The root is described above an inch thick, and six inches in length; externally black, with several vermicular branching fibres, clothed with tawny or golden pubescence. Stalk of each frond near eighteen inches high, pale brown and smooth, leafy from its middle part to the summit, where it terminates in a large erect leaflet, constructed exactly like the rest, being equal in size to the larger lateral ones, and considerably exceeding those immediately below it. Such is the habit of *W. angustifolia*, but not of the other species in general.

WOODY Fibrous Matter, in Agriculture, that which is produced from small particles of different sorts of woody substances.

When merely formed of these parts, it is supposed to be the only vegetable matter that requires the aid of fermentation to render it nutritive to plants. The used bark of the tanner is a substance of this sort, which is very absorbent and retentive of moisture, but not penetrable by the roots of plants. See TANNERS' Bark.

Woody fibrous matter may likewise be prepared so as to become a manure, by the action of lime upon it.

It is observed in the “Elements of Agricultural Chemistry,” that as woody fibre consists principally of the elements of water and carbon, the latter being in larger quantities than in the other vegetable compounds, any process that tends to abstract carbonaceous matter from it, must bring it nearer in composition to the soluble principles; and that this is done in fermentation, by the absorption of oxygen and production of carbonic acid; and that a similar effect is produced by lime. See LIME.

WOODY Nightshade. See NIGHTSHADE.

WOODY Head, in Geography, a high cape on the coast of New Zealand, in the South Pacific ocean. S. lat. 37° 42'.

WOODY Island, an island in the East Indian sea. N. lat. 1° 46'. E. long. 106° 5'. See VICTOIRE.

WOODY Point, a cape on the west coast of North America. N. lat. 50°. W. long. 128° 5'.

WOODYCUTTY, a town of Hindoostan, in Canara; 8 miles E. of Onore.

WOOF, among *Manufacturers*, the threads which the weavers shoot across, with an instrument called the *shuttle*, between the threads of the warp, to form the web.

The wool is of different matter, according to the piece to be wrought. In taffety, both wool and warp are silk. In mohairs, the wool is usually flax, and the warp silk. In fattins, the warp is frequently wool, and the wool silk.

WOOFE, a name given in some parts of England to the sea-wolf, or *lupus marinus*; which see.

WOOGINOOS, in *Botany*. See BRUCEA *Antidy-senterica*.

WOO-HOO-SHIEN, in *Geography*, a town of China, in the province of Kiang-nan, near the river Yang-tse-kiang, a narrow cut leading from the river to the city, and flowing through the suburbs. This is a place of considerable trade; in the suburb there are several good dwelling-houses, apparently belonging to persons of distinction; and in the city itself there are many shops, which, it is said, would not disgrace the Strand or Oxford-street in London. These shops are spacious, consisting of an inner and outward compartment, and well supplied with articles of all kinds, both of raw and manufactured produce. The porcelain shops are particularly large, and contain great varieties of the manufacture. The main street leading directly through the city is not less than a mile in length. Several streets branch off from this, which are all paved, and contain good houses. The number of shops that are filled with lanterns of all descriptions, both horn and paper, indicate manufactories of those articles. The principal wall of the city extends on the north face; and the other is so overtopped with houses, that it almost escapes notice in passing down the main street, which it crosses. On the declivity of a hill to the northward are the temple and ancient tower. The temple, to which there is an ascent by a very steep stone stair-case, resembles that at Nankin, the god Fo being represented by the same attributes, and the principal hall being surrounded by similar figures of sages, in the same style. In another temple in the suburb there was a greater resemblance to that of Nankin. Woo-hoo-shien does not seem to be populous in proportion to the number of shops, and the quantity of accumulated produce exposed for sale. The suburb near the city contains several good shops, which were crowded with people. Ellis's *Journal of the late Embassy to China*, vol. ii. Lond. 1818.

WOJEDA, a town of Algiers, in the province of Tremecen, anciently called Guagida; 20 miles W.S.W. of Tremecen.

WOOL, in *Natural History* and *Manufactures*, Latin *lana*, *lanicium*, Fr. *laine*, signifies soft hair or down, more particularly that of sheep, but is applied to the soft hair of other animals, as of the vicunna, commonly called Vigonia wool, that of the yak of Tartary, &c.; and also to fine vegetable fibres, as cotton. The Romans applied the term extensively to the soft hair or down of all quadrupeds, and even to that of birds, as *lana anserina*, the wool or down of the goose; *lana caprina*, goat's-wool.

They also applied the term to vegetable substances:

—“*Nemora Æthiopiæ molli canentia lana.*”

Virg. Georg. ii. 120.

“The trees of Ethiopia, white with soft wool, or cotton.”

The distinction between wool and hair is rather arbitrary than natural, consisting in the greater or lesser degrees of fineness, softness, and pliability of the fibres. When they possess these properties so far as to admit of their being spun and woven into a texture sufficiently pliable to be used as an article of dress, they are called wool. The gradations between wool and hair on the skins of some animals are often too minute to admit of accurate distinction. The fleeces of many sheep contain fibres so hard and coarse, that they may most properly be called hair; and some hairy animals produce on part of their skins fibres possessing all the properties of wool; even in fleeces from the sheep, we may sometimes observe the very same fibre to be a coarse hair at one end, and at the other end a comparatively soft wool. The power of words, when inaccurately applied in retarding the progress of improvement, may frequently be traced in the most common occurrences of life, and we are persuaded it has had no inconsiderable effect in this instance, in preventing the cultivation of wool, in Europe, on the skins of other animals besides sheep. No one will deny that it is impossible to produce wool on the backs of the ox or the ass, if we restrict the term wool to the fleece of the sheep; but if by wool we mean a soft fine hair, possessing all the properties which render it suitable to be spun, woven, and fulled, to make cloth, the oxen of Thibet and the asses of Chili do produce and have for centuries produced such wool. Many of the asses and oxen even in this kingdom have soft woolly tufts of hair on some parts of their skins, and if such cattle were selected, and the breed cultivated, it is probable we might obtain from them a valuable addition to the materials on which national industry might be profitably employed.

Sheep's-wool appears to be the product of cultivation; we know of no wild animal which resembles the wool-bearing sheep. The argali, from which all the varieties of sheep are supposed to be derived, is covered with short hair, at the bottom of which, close to the skin, there is a softer hair, or down. (See ARGALI and SHEEP.) This is not peculiar to the argali; almost all quadrupeds inhabiting cold climates are covered in the same manner with a soft hair or down, which is protected by a coat of longer and coarser hair. By removal to a temperate climate, or when placed under the fostering care of man, and protected from the inclemencies of the weather, and supplied regularly with food, the coarse long hair falls off, and the animal retains only the softer and shorter hair, or wool. It is also observed that European sheep, removed to tropical climates and much exposed, soon become languid and sickly, and lose their fleece, which is succeeded by a covering of short coarse hair. Sheep in exposed situations in Europe often produce short coarse white hairs called kemps, intermixed with the finer wool; on removal to a warmer situation, and to a richer pasture, the coarse hairs fall off, and do not grow again. These facts are sufficient to prove the effect of cultivation on the fleece; and it must be observed that sheep's-wool of a good quality is never found but in those countries which have been the seats of the arts, and where a considerable degree of luxury or refinement exists, or has once prevailed. This is a strong presumptive proof that such wool has been originally obtained by a careful and long-continued attention to the selection of those sheep which produced the finest and most valued fleeces.

Angora, the ancient Ancyra, the former seat of arts and manufactures, still retains its breed of fine-woolled animals, among which the goat at the present time produces a fleece nearly equal to silk in lustre and fineness; and the cat and the rabbit of that district yet produce fine long wool. Damascus, and the other ancient cities of Asia Minor, preserve

in their vicinity the traces of the former cultivation of fine-woolled animals. The Tarentine fine-woolled sheep, so much valued by the Greeks and Romans, were obtained from Asia Minor, and were on that account sometimes called Asiæ. It is highly probable that these sheep came originally from the more eastern seats of luxury, where the soft fleeces are now grown, of which the shawls and cloths of India are fabricated.

In countries where manufactures have once flourished, their effects continue for a long time visible in the race of sheep which still remain there. Even in the present condition of the fleeces from Barbary and the adjoining states, the experienced eye may perceive the vestiges of a fine-woolled race of sheep, degenerated by utter neglect, in a climate naturally unfavourable to the production of fine wool. In Sicily and the southern parts of Italy, the remains of the ancient Tarentine breed preserve to the present day a race of fine-woolled sheep, but greatly degenerated by neglect. In Portugal the fine-woolled sheep retain more of their original purity, but are still much neglected. In Spain attention to the growth of fine wool appears never to have been entirely lost sight of, and it is here that the race of fine-woolled sheep exist in the highest degree of perfection, though, as we shall afterwards state, probably inferior in some important qualities to the original Tarentine race. Some writers have asserted that fine wool is the result of climate and food; but this is not the fact, though we admit that both have some influence on the quality of wool. It is the breed alone that primarily determines the fineness of the fleece; this has been ably demonstrated by the experiments of lord Sommerville, Dr. Parry of Bath, and others in this country, and by experiments on a larger scale in Sweden, Denmark, Saxony, and France.

It has been ascertained by Mr. Bakewell of Dishley, in Leicestershire, that the form of animals might be changed by selecting such as had any remarkable peculiarities, and continuing to breed from them for a few generations, when a new race is established, in which these peculiarities continue permanent. It has been ascertained by careful observations, both of cattle-breeders and physiologists, that in producing a new breed from two varieties of the same species, the female has more influence over the form of the progeny than the male; but with respect to wool the case is reversed, the quality of the fleece depending more on the sire than the dam. Beginning to breed from a coarse-woolled ewe and a pure fine-woolled ram, the produce of the first crosses will have a fleece approaching one-half to the fineness of that of the ram; and continuing to cross this progeny with a fine-woolled ram, equal to the first in quality, the fleece of the score and crosses will approach three-fourths to the fineness of the first, and in a few crosses more will be brought to an equal quality. If we state it numerically, and suppose the wool of the ewe to be twice as coarse as that of the ram, or as 320 to 160, the first crosses will have the fibre reduced to 240, the second to 200, the third to 180, the fourth to 170, the fifth to 165, the sixth to $162\frac{1}{2}$, which to all practical purposes may be regarded as equal to the first number. This ratio of approximation may be stated as correct on a large scale of experiment. If we breed with a fine-woolled ewe and a coarse-woolled ram, the series would be reversed, and in a few generations all vestiges of the fine-woolled race would be nearly, if not entirely, extinct. The ancient Romans, in the time of Columella, seem to have been fully aware of the effects of breed on the fineness of the wool, and as much as 200*l.* sterling was paid for a fine-woolled ram.

When a flock of fine-woolled sheep are once formed, they can only be kept pure by selecting and preserving the

finest-woolled rams, and most carefully avoiding all intermixture with sheep from coarser-woolled flocks that may exist in the country. Where this is neglected, the quality of the wool will soon be debased.

But supposing all the flocks in a country were of the fine-woolled race, accidental varieties of coarse-woolled sheep will occur among them, or of sheep having fleeces intermixed with coarse hair. If these be not carefully examined and removed, the wool will deteriorate, and more so where the climate is variable, and the sheep are exposed to great and sudden vicissitudes of temperature.

What has been stated may suffice to explain the circumstance of fine-woolled breeds of sheep being only found in the vicinity of present or ancient manufactures, or where they have been transported from such districts. Wherever fine-woolled sheep are neglected by man, the wool becomes either coarse, or intermixed with coarse hairs; the latter is the case in the Shetland isles, and in all countries where the arts and manufactures have been entirely destroyed, and ignorant barbarians have succeeded as the possessors of the soil.

Most ancient writers on wool, and even many moderns, seem not to be aware of any difference in wools, except the fineness or coarseness of the fibre; but the length of the fibre constitutes a far more important distinctive character. Long wool, or what is called combing-wool, differs more from short or clothing wool, in the uses to which it is applied, and the mode of manufacture, than flax from cotton.

Sheep's-wool may, therefore, be divided into two kinds. Short wool, or clothing-wool, and long or combing wool: each of these kinds may be subdivided into a variety of sorts, according to their degrees of fineness. This process is the proper labour of the wool-sorter.

Short wool, or clothing-wool, may vary in length from one to three or four inches; if it be longer it requires to be cut or broken, to prepare it for the further processes of the cloth manufacture. Short or clothing wool is always carded or broken upon an instrument with fine short teeth, by which the fibres are opened and spread in every direction, and the fabrics made from it are subjected to the process of felting, which we shall afterwards describe. By this process, the fibres become matted together, and the texture rendered more compact.

Long or combing wool may vary in length from three to eight or ten inches: it is prepared on a comb or instrument, with rows of long steel teeth, which open the fibres, and arrange them longitudinally: in the thread spun from combed wool, the fibres or filaments of the wool are arranged in the same manner, or similar to those of flax, and the pieces when woven are not subjected to the process of felting.

The shorter combing-wools are principally used for hose, and are spun softer than the longer combing-wools, the former being made into what is called hard worsted yarn, and the latter into soft worsted yarn.

Short Clothing-Wool.—The principal qualities deserving attention in clothing-wools are the regular fineness of the hair or pile, its softness and tendency to felt, the length and soundness of the staple, and the colour. The wool-buyer also regards as important the clean state of the fleece, and to the grower its weight is particularly deserving attention; for in fleeces equally fine, from sheep of the same size, some may be much heavier than others, the fibres of wool being grown closer to each other on the skin.

The fineness of the hair or fibre can only be estimated to any useful purpose, in the woollen manufacture, by the wool-sorter or wool-dealer, accustomed by long habit to discern

discern a minute difference, which is quite imperceptible to common observers, and scarcely appreciable by the most powerful microscopes. Of the various attempts that have been made to reduce the fineness of wool to a certain standard, by admeasurement with a micrometer, we shall afterwards speak. From some experiments we have made, as well as from those made by Mr. Luccock, Dr. Parry, and others, we may estimate the thickness of the hair of the finest Spanish and Saxony wool to be not more than the fifteen-hundredth part of an inch, and that of the finest native English to be from twelve to thirteen-hundredth parts, whilst the inferior sorts gradually increase to the six-hundredth part of an inch and more. A difference in the size of these fibres, too minute to be noticed by the common observer, may occasion a difference of 40 *per cent.* or more in the value of the wool. The fineness of the hair has been ever considered as an important quality since the clothing manufacture emerged from its rudest state. Fine wool was formerly valued because a finer thread could be spun from it, and a thinner fabric made, than from the coarser wools; but since recent mechanical improvements have been introduced into the woollen manufacture, it has been found practicable to spin coarse wools to the same length as the finer wools were formerly spun to. It is well known, however, to cloth-manufacturers, that whatever be the fineness of the yarn, unless the wool be fine, it is impossible to make a fine, compact, and even cloth, in which the thread shall be covered with a thick soft pile; nor would a thin cloth made from coarse wool have the same durability or appearance as one from fine wool of equal weight *per yard*. Fine wool will, therefore, always preserve a superior value to the coarse; indeed it was long considered as the principal and almost the only quality deserving the attention of the wool-grower, the wool-stapler, and the clothier.

The regular fineness of the fibre is also an object of considerable importance; the lower end of the staple, or that part of the fleece nearest the skin, will sometimes be very fine, and the upper part coarse. In some fine fleeces there will frequently be an intermixture of long, silvery, coarse hairs, and in other fine fleeces an intermixture of short, thick, opaque hairs, called kemps. When the wool is thus irregularly fine or intermixed, it is technically called not being *true grown*. The fine fleeces of Spain and Portugal, particularly of the latter country, are many of them injured by the intermixture of the long silvery hairs before-mentioned: whether this be owing to the original Tarentine breed having been crossed with the coarse-woolled native sheep of Spain, (see the article SHEEP,) and still preserving a tendency to revert to their first condition, or whether it be the effect of heat on the skin, is uncertain. The Saxony fleeces, from the same breed, removed to colder climates, are generally free from this defect. The coarse short hairs, or kemps, are not uncommon in some of the fine-woolled flocks of England and Wales, particularly those which are more exposed to the inclemencies of the weather, and have a scanty or irregular supply of food. It has been observed, in the first part of the article SHEEP, that in some flocks the proportion of fine wool in each fleece is much greater than in others, for in few or none is the wool grown uniformly fine over the whole body.

On the Merino sheep the fleece is more regular, whatever be the degree of fineness, than on any of our native English fine-woolled breeds. The Merino fleece admits of a division into four sorts, the *refina*, the *fina*, and the *tercera*, with a very minute portion of coarse from the shanks and head, which is not sent to market. The three sorts are distinguished in commerce by the marks R, F, and T.

On the average, there will be in each fleece nearly three-fourths of the best or R wool. The second and third sorts, or the F and T, will also contain a considerable portion as fine as the best; but being shorter and discoloured, or intermixed with coarse hairs, which require their locks to be separated from the best sort, or the refina.

In the native English fleeces, however fine some part may be, the proportion of the best sort rarely exceeds one-third part, and is frequently not more than one-sixth part of the whole fleece.

The value of the best part of a Spanish fleece, or the R wool, varies greatly in different flocks. When this sort, from the most esteemed flocks, may be worth six shillings and sixpence *per pound* in the English market, the R wool from another flock may not be worth more than three shillings and sixpence. The F and T wools are from 25 to 50 *per cent.* lower than the first sort: thus, the inferior sorts from the finest piles may be of greater value than the best sort or R wool of other piles; but they are never intermixed by the dealers, as they are applicable to different fabrics. In the English mode of wool-sorting, there will frequently be eight or ten sorts in a single fleece; and if the best wool of one fleece be not equal to the finest sort, it is thrown to a second, third, or fourth, or a still lower sort, which is of an equal degree of fineness with it. The best English short native fleeces, such as the fine Norfolk and South Down, are generally divided by the wool-sorter into the following sorts, varying in degree of fineness from each other, which are called,

Prime,
Choice,
Super,
Head,
Downrights,
Seconds,
Fine abb,
Coarse abb,
Livery,
Short coarse or breech wool.

Besides these sorts of white clothing wool, two and generally three sorts of grey wool are made, consisting of locks which may be black, or intermixed with grey hairs. Some wool-sorters also throw out any remarkably fine locks in the prime, and make a small quantity of a superior sort, which they call picklock. The origin of some of the above names is obscure, but the names of the finer sorts appear to indicate either a progressive improvement in the quality of the wool, or in the art of wool-sorting. The relative value of each sort varies considerably, according to the greater demand for coarse, fine, or middle cloths; and the variation during and since the late war in the Spanish peninsula has been much increased by temporary causes. Before that period, when the R wool of good Spanish piles sold at from five shillings and sixpence to six shillings *per pound*, the prime from Herefordshire fleeces was sold at about three shillings and sixpence, and that from the Norfolk and South Down from three shillings to three shillings and two-pence *per pound*. The higher price of the Herefordshire was in part owing to its being in a cleaner state. The Spanish wool is also cleaner than any of the English wools, being scoured after it is shorn; but the latter is only imperfectly washed on the sheep, previously to its being shorn. A pack of English clothing wool of 240 pounds weight, in its marketable state, will waste about 70 pounds in the process of the manufacture: the same quantity of Spanish wool, as sent to market, will not waste more than 43 pounds

on the average. This contributes to enhance the difference between the prices of each, as well as the superior fineness of the latter.

Different wool-sorters make a considerable variation in their modes of sorting the same kind of fleeces: some divide them into more sorts than others; but the following table will shew what may be taken as the average relative value of each sort, when the prime is worth about three shillings and two-pence *per* pound, and may serve to shew the skill required to estimate the value of fine English wool in the fleece.

	<i>s.</i>	<i>d.</i>		<i>s.</i>	<i>d.</i>	
Prime	-	3	0	to	3	4
Choice	-	2	4	to	2	8
Super	-	2	0	to	2	2
Head	-	1	8	to	1	10
Downrights	-	1	5	to	1	6
Seconds	-	1	3	to	1	4
Fine abb	-	1	0	to	1	1
Coarse ditto	-	0	9	to	0	10
Livery	-	0	8	to	0	10
Short coarse	-	0	7	to	0	8

The demand for coarse woollen goods having greatly increased of late, the prices of the lower sorts are considerably advanced from the above-stated prices, and are at present as under:

	<i>s.</i>	<i>d.</i>	
Short coarse	-	1	4
Livery	-	1	5
Fine abb	-	1	6
Seconds	-	1	7
Downrights	-	1	8
Head	-	1	10
Super	-	2	0
Choice	-	2	2
Prime	-	2	6
Picklock	-	3	0

} *per* pound in London.

The Softness of fine clothing Wool is next in importance to the fineness of the fibre, though it has been too little attended to in the culture of English wool. This quality is not dependent on the fineness of the fibre; it consists in the peculiar feel which approaches to that of silk or down, but in which the wool of all European sheep is inferior to that of Eastern Asia, or to the wool of the vicunna, or lama of Peru and Chili. In foreign European wools there are different degrees of this property, where the fibre is equally fine. In our native English wools, the like difference exists between the softness of wool possessing the same degree of fineness, but grown in different districts. In the harder wool, the fibre is elastic and hard to the touch, and cloth made from it has the same harsh feel; it is also more loose in its texture, and the surface of the thread is generally more bare. The difference in the value of cloth from two kinds of wool, equally fine, but one distinguished for its softness, and the other for the contrary quality, is such, that with the same process and expence of manufacture, the one will make a cloth more valuable than the other from twenty to twenty-five *per cent*.

Though the English woollen manufactures had been carried on for so long a period, the cause of this difference in cloths made from wool equally fine was but very imperfectly known till the present century. Mr. Robert Bakewell, then of Wakefield in Yorkshire, first directed the attention of wool-growers and manufacturers to this subject, in a work, entitled "Observations on the Influence of Soil and Climate

on Wool." The reason why the manufacturers remained so long ignorant respecting it arose, he observed, from the manner in which the woollen-trade had been carried on in Yorkshire, the great feat of the manufacture of English clothing-wool, the division of employment there not permitting the wool-dealer, or even the clothier, to witness the final result of the process. The wool-buyer in the distant counties, and the wool-sorter, who divided the fleece, were equally unacquainted with the cloth manufacture. The Yorkshire clothier sold his goods in an undressed, and often in an undyed state; they were bought and finished by the cloth merchant, who was formerly unacquainted with the previous processes of the manufacture, or the qualities of wool. In a promiscuous lot of undressed cloth bought at the same price, and apparently of the same quality in the rough state, if some pieces were finished much better and softer than others, it was attributed to lucky chance, the patron divinity of the ignorant. Mr. Bakewell proved that the hardness of English wools does not depend on the nature of the food, or even entirely on the breed; it is the effect of the soil acting on the surface of the fleece. The wools from chalk districts, or light dry calcareous soils, have the natural yolk or moisture absorbed by the particles of calcareous earth that penetrate the fleece, and the wool is thereby rendered hard. The same effect is produced on a skin where lime is used; it may also be produced by keeping wool for a longer or shorter time in a dry hot temperature; and when wool has been so dried, no process will restore to it its pristine softness. On the contrary, wools grown on rich loamy argillaceous soils are always distinguished for their softness. The quantity of grease or yolk in the fleece has a considerable degree of influence on the softness of Merino wool, the pile being so close as in a considerable degree to prevent the earthy particles from penetrating the fleece; but in all English fleeces the wool is grown thinner on the skin, and admits the more easy access of the absorbent particles. Exposure to the direct rays of a summer sun has also a tendency to injure the soft quality of the wool. We shall have occasion to refer to the methods recommended by Mr. Bakewell to improve the softness of wool on soils naturally unfavourable to its growth.

Of fine European wools, the Saxony generally possesses a greater degree of softness than the Spanish, which we believe to be owing to the sheep being less exposed to the action of light and heat. The native fine Italian wool, before the introduction of the Merino race, possessed a considerable degree of softness, judging from wools which we have seen from thence, but they were deficient in soundness, and not *true grown*. The wools on the chalk soils in the southern and eastern side of England are generally hard, except, as in Kent, where the chalk is covered by thick argillaceous beds. Nottingham forest, Chamwood forest in Leicestershire, and some parts of Shropshire, produced not the finest, but some of the softest wools in England before the late inclosures. The Cheviot hills in Cumberland are not pastured by the finest-woolled English sheep, but their fleeces possess a degree of softness exceeding any from the other districts of England, and they are rendered soft by artificial means, which we shall describe. It is still somewhat uncertain, whether there are two distinct breeds of sheep, from which the fine shawl wool of India are grown; or whether one species of the animal which yields it is not to be classed with the goat. The fleeces from India, which we have seen, are grown on a very small sheep; close to the skin, there is a wool as soft as the softest fur; this is covered by long coarse hairs growing through it. When the wool is once shorn, the separation of these hairs from the soft wool

wool is a work of extreme difficulty; but on the back of the sheep we believe the separation can be made with great ease. The softness of the Indian wool is not even distantly approached in the very softest Merino fleeces from Saxony and Spain; this may be proved by comparing the finest cassimere cloth from Saxony wool, with the shawls or shawl-cloth of India. The ancient Tarentine sheep, called by way of excellence 'molles oves,' were treated with peculiar care by the Romans, and clothed in skins, which we believe was intended to preserve the softness of the wool, as it is still practised in some parts of Asia for that purpose. In Europe no experiments have been made directly to improve the softness of wool, though wool approaching in softness to that of India would be a most valuable acquisition to our manufactures. To be convinced of this, it need only be stated, that the yarn from Indian wool has been sold here at three guineas *per* pound, not on account of the superior fineness of the spinning, but for the softness of the wool. For coarse goods, indeed, such as blankets, carpets, and cloths called duffields, raised with a hairy pile, a considerable degree of hardness or elasticity of the fibre is an advantage; but in all the finer articles of the woollen or worsted manufacture, the opposite quality is of great value.

The felting property of wool is intimately connected with its softness, the softest wools having the greatest tendency to felt, and the hard wools are all defective in this respect. The felting property appears to depend on a peculiar structure of the surface of the fibres, by which they are disposed to move in one direction more easily than another. This is perceptible in drawing a hair through the fingers, first from the end to the point, and again from the point to the end; in one direction the hair feels perfectly smooth, in the other direction a peculiar roughness is felt. The cause of this is supposed to be owing to the surface of the fibres having laminæ, like the scales of fishes, with the edges laid over each other. Indeed in the furs of some animals we have observed with a powerful microscope, that the surface is composed of laminæ laid over each other, resembling the arrangement of the leaves of the artichoke. On this property the process of hat-making depends; the short fibres of the fur being repeatedly compressed, move and interlock with each other, so as to form a compact substance; this motion is further aided by heat and moisture. A similar process takes place to a certain degree in cloth subjected to the strokes of a fulling-mill; the fibres cohere, and the piece contracts in length and breadth, and its texture is rendered more compact and uniform. This process is essential to the beauty and strength of woollen cloth; and it is observed, that the softer wools felt in much less time than the harder, and form a closer pile on the surface of the cloth, on which account it is a common practice to mix a certain quantity of soft wool with the hard, to enable the former to felt with more facility.

The length and soundness of the staple of clothing wool is the quality next to be considered. By the staple of wool is meant the separate locks into which the fleece naturally divides in the skin, each lock consisting of a certain number of fibres, which collectively are called the staple.

The best length of staple for fine clothing-wool, if found, is from two to three inches. If it be longer it requires breaking down to prepare it for the process of carding. Saxony wool, being generally more tender than the Spanish, and more easily broken down, is sometimes four or five inches long; but as it works down easily, it is preferred, on account of the length of its staple, for such goods which

require fine spinning, as cassimeres, pelisse cloth, and shawls. Much of the English clothing-wool of a middle quality is grown longer than is desirable for the purpose of the clothier, and when found is thrown out for the hosiery trade, if the demand for the latter be great. As the grower could not shorten the length of the staple without diminishing the weight of the fleece, he has no motive to induce him to grow shorter wool; but the object might be obtained with much benefit to himself by shearing twice in the year, once the latter end of April, and again the latter end of August; the wool would then be grown of a suitable length for the card, and from experiments that have been made we believe the weight would exceed what can be obtained from one clip: the increase would not be less than fifteen *per cent.*, and the condition of the sheep thereby improved.

The soundness of the staple in clothing-wools is not so important as in combing-wools; but for some kinds of colours which injure the wool, it is particularly desirable that the fibre should be sound and strong; this is judged of by drawing out the staple and pulling it by both ends. The soundness and strength of the staple depend primarily on the healthy state of the animal, and on a sufficient supply of food. The staple on some parts of the fleece will always be more tender than on other parts, but by mixture they tend to form a dense pile on the surface of the cloth.

The colour of the fleece should always approach as much as possible to the purest white, because such wool is not only necessary for cloths dressed white, but for all cloths to be dyed bright colours, for which a clear white ground is required, to give a due degree of richness and lustre. It is probable that all sheep's-wool was first of a black or reddish colour: the latter is often referred to by the ancients. Before the invention of dyeing, coloured wool must have had a preference to white; but after the act of communicating beautiful colours to the fleece, white wool would be in the greatest demand, and those sheep which had white fleeces would be selected to breed from. The most ancient flocks of sheep which we have any record of are those of Laban and Jacob, described in the book of Genesis. The fleeces appear to have been principally brown, or spotted and striped, which was in all probability the general colour of the flocks throughout that part of Asia. We learn that in the course of twenty years a great change was effected in the colour of a large portion of the sheep of Laban: though Jacob appears to have concealed from his father-in-law the method by which this change was effected, we are expressly told in the sequel that it was by crossing with rams which had fleeces of the colours required.

Dark-brown or black woolled sheep are not uncommon in many parts of the European flocks, but such wool being of less value than the white, these sheep ought always to be expelled. Some of the English fine-woolled sheep, as the Norfolk and South-Down, have black or grey faces and legs. In all such sheep there is a tendency to grow grey wool on some part of the body, or to produce some grey fibres intermixed with the fleece, which renders the wool unfit for many kinds of white goods; for though the black hairs may be too few or minute to be detected by the wool-sorter, yet when the cloth is stoved they will become visible, forming reddish spots, by which its appearance is much injured. The Herefordshire sheep, which have white faces, are entirely free from this defect, and yield a fleece without any admixture of grey hairs. We have no doubt that by carefully rejecting those sheep from the South-Down flocks, in which the grey is most apparent, this defect might be gradually removed. It is particularly desirable with respect

to these sheep, as the wool grown on chalk soils, though less soft than on other soils, is generally whiter, and better suited to such goods which require the process of bleaching or stoving, and do not require to be so much fulled as many other cloths.

The ancients were so well aware of the necessity of expelling dark-coloured wool from their flocks, that in selecting the sheep to breed from, they did not trust to the colour of the fleece alone, but carefully examined the mouth and tongue of the ram, and if the least blackness or swarthiness appeared he was immediately rejected; and though some moderns have doubted the use of this precaution, we believe it was well founded.

“ Illum autem, quamvis aries sit candidus ipse,
Nigra subest udo tantum cui lingua palato,
Rejice, ne maculis infuscet vellera pullis
Nascentem.” Vir. Georg. iii.

Pliny also states, that particular attention was on this account had to the colour of the mouth. “Arietum maxime spectantur ora.” We are informed that this kind of inspection takes place in the Spanish flocks at present, a practice in all probability derived from the Roman shepherds, as we believe the flock to have been from those of Italy, or the Tarentine breed. The colour of the soil on which sheep graze, if very dark or red, communicates to the wool a tint more or less strong, which is indelible, and renders such wool less proper for cloths or hosiery goods that are to be finished white; for though the colour may be improved by stoving, yet on washing the cloths, they soon return to a brownish or yellowish tint. The tint from the soil is, however, rarely of sufficient strength to be regarded for dyed goods, excepting for exceedingly light colours.

The cleanness of wool is principally regarded by the purchaser, as it affects the weight. To the grower those fleeces are generally the most profitable that are well filled with the grease, or yolk as it is called, because it keeps the wool in a sound state, and improves its softness. It ought, however, to be washed out as much as possible before it is exposed to sale. The fleeces of the Merino sheep are more plentifully supplied with yolk than those of any of our native fine-woolled breeds; indeed it is so abundant, that the English mode of washing on the back of the sheep will scarcely produce any effect upon the fleece. The yolk or grease in the fleece appears, from the experiments made upon it by M. Vauquelin, to be a native soap, consisting principally of animal oil combined with potash. It is most copiously produced in those breeds which grow the finest and softest wool, and is always most abundant on those parts of the animal which yield the finest parts of the fleece. To this subject we shall again refer in treating of the improvement of wool. This yolk, though so beneficial to the wool in a growing state, becomes injurious to it when shorn; for if the fleeces remain piled in an unwashed state, a fermentation takes place, the yolk becomes hard, and the fibre is rendered hard and brittle. This effect takes place more rapidly in hot weather. The Spaniards remove this yolk in a great measure by washing the wool after it is shorn and sorted. In Saxony fine-woolled sheep of the same race are washed in tubs with warm water, soap-lees, and urine, and afterwards in clean water.

In England the wool is washed on the back of the sheep by immersing the animal in water, and squeezing the fleece with the hand. From these different modes of washing, the wool is left more or less pure. Mr. Bakewell, in his Ob-

servations on the Influence of Soil and Climate on Wool, has given the following table, containing a statement of the quantity of neat wool in every hundred pounds, taken on an average of each sort, and supposing each to be free from lumps of pitch employed in marking the wool, and cleared from what are called the *dog-locks*. The first column represents the average weight after the wool has been scoured perfectly clean with soap and water, and dried; the second the amount of waste.

	Pure Wool.	Waste.
100 lbs. of English wool washed on the sheep's back	75	25
Ditto Saxony fleece-wool	80	20
Ditto Spanish R, or refine	88	12
Ditto Spanish and Portugal unwashed	75	55
Ditto English fleeces unwashed	60	40
Ditto lightly greased wools of Northumberland washed on the sheep's back	65	55

Hence it is obvious, that the state of the fleece with respect to cleanness is an object of great importance to the wool-buyer. The English Merino sheep, from the difficulty of washing the wool on the sheep's back, have generally been shorn in an unwashed state, and the wool offered for sale in this state. The purchasers were frequently unacquainted with the great amount of the loss it would suffer by washing, and were much disappointed at the result. This circumstance, we conceive, more than any other, tended to prejudice the manufacturer against the Anglo-Merino wool. The wool is also injured by remaining in the grease, as we have before stated, and though this has been contradicted, we have no hesitation in asserting the fact from our own experience. Indeed the French manufacturers of fine cloth assert, that the best wools from Spain, though cleared in a great measure from the yolk, yet still retain sufficient to injure the wool if it be suffered to grow old when it is packed, the yolk becoming rancid and hard, and communicating the latter property to the wool. We have frequently observed this effect in the wools from Portugal, that retain a greater portion of the yolk than those from Spain.

After wool has been washed in the usual manner practiced in England, and piled or packed, a certain process takes place in eight or nine weeks, called *sweating*. This is well known to wool-dealers and manufacturers, but has not been before noticed by any writer that we are acquainted with. It is evidently an incipient fermentation of the remaining yolk; and the inner part of the pack or pile becomes sensibly warm. This process produces a certain change in the wool, whereby it becomes in a better condition for manufacturing, being what is called in the north of England less *fuzzy*. This effect results from a diminution of the natural elasticity of the fibre.

When this fermentation takes place in unwashed wool, it proceeds farther, and injures the colour and soundness of the staple or fibre. A similar effect is produced in wool or cloth which has been oiled, and remains some time in an unscoured state. Instances of spontaneous combustion from heaps of refuse wool remaining in a greasy state have been known to occur, and occasion the most serious accidents in woollen factories.

The weight of the fleece is an object of great importance to the grower. It is generally supposed by the English wool-dealers, that an increase of weight implied an increase of coarseness; indeed the words coarse and heavy are considered by them as synonymous, but this is not absolutely

WOOL.

Parts of an Inch.

Prime	-	-	-	1120
Choice	-	-	-	1074
Super	-	-	-	1028
Head	-	-	-	982
Downrights	-	-	-	936
Seconds	-	-	-	890
Abb	-	-	-	844
Fine livery (variable)	-	-	-	798

The method of measurement adopted by Mr. Luccock might be sufficiently correct with the deduction of one-fifth, were the instrument always used by the same person, and a similar degree of pressure given in each experiment; but as this is required, it becomes uncertain in its results, and inadequate to practical purposes.

Dr. Parry's method of measurement is effected with an instrument similar in principle to the lamp micrometer of Dr. Herschel, of which an account is published in the Philosophical Transactions for 1782. (See MICROMETER.) An object of a known diameter being placed in the focus of a compound microscope, and strongly illuminated, a piece of white paper is placed horizontally at some distance beneath it; then looking through the microscope with one eye, and keeping the other steadily open, you will see the object apparently projected on the paper, which is to be measured, whilst viewing it, with a pair of compasses. Divide the length of the image so measured with the known diameter of the object, which will give the magnifying power of the microscope. This being found, place the object you wish to measure in the focus, and projecting its image on the paper as before, measure it with the compasses, and divide the result by the magnifying power, which will be the real magnitude of the object required.

The light of a lamp is to be preferred to day-light, and the fibres to be measured are to be stretched on a glass, and waxed down at both ends. The under side of the glass should be blackened with Indian ink, except in three parts, the middle, and near the two ends. The unblackened spaces being placed in the focus of the microscope, ten or more filaments may be examined and measured successively, both in the middle part of the glass, and near the ends, which will give the diameter of the filament at the upper and lower end of the staple, and in the middle. Each lock of ten filaments being thus examined in three different parts, the mean of the three measurements must be taken for the mean diameter of each filament, and the mean diameter of the ten filaments may be taken for the fineness of the whole lock.

In place of the blackened glass, we would recommend a thin slide of ivory or brass, about five inches in length, and half an inch in breadth, with three transverse slits or openings, one in the middle, and the two others about three-fourths of an inch from each end. On this slide the filaments may be stretched, it will not be liable to break, and the edges of the filaments will be more correctly defined than when a plate of glass is placed under them.

The farther the paper is removed from the eye, the larger will be the apparent space covered by the image of the object, but it must not be too far for the hand to measure it with compasses. But if in place of the compasses we have a sheet of pasteboard graduated into minute divisions from a black line upwards, and a sliding index be adjusted, the pasteboard may be placed at a much greater distance, the observer adjusting the slide, until the edge of it and the black line coincide with both edges of the filament. An

the case; a fleece grown upon the same animal may be increased in weight either by the fibres becoming coarser, or by their being grown longer, or by a greater number of fibres being grown in the same skin. To the wool-grower it can never answer to increase the weight of the fleece on small fine-woolled sheep, by growing the wool coarser; if this be his object, the long-woolled breeds of sheep are to be preferred. He may produce wool somewhat longer by increasing the quantity of food; but it generally loses something of its fineness, and is less suitable for the cloth trade. He may, however, increase the weight considerably by selecting such breeds as grow the wool close upon the skin, and are thickly covered with wool over every part of the body. In this respect, the Merino sheep have greatly the advantage over any of the native breeds of English sheep; many of them yielding from three to four pounds of pure wool, whilst the finest English fleeces rarely exceed two pounds, and would lose one-fourth of this weight when brought to a pure state by scouring. It has been doubted whether all sheep's-wool, when clean, possesses the same specific gravity; but admitting there may be some variation in the wool from different piles, we conceive that it is too minute to deserve the attention of the wool-grower or manufacturer.

The filaments of fine wool being so minute, it requires an eye habituated by long experience to appreciate the relative fineness of two piles, which may differ in value as much as twenty-five per cent. Even those who have been long practised in such examinations find it difficult to form immediately a correct opinion of the fineness, if they are removed for a few weeks from all opportunity of viewing wool. It is not surprising then that the wool-grower, who only directs his attention to the subject during one part of the year, should often be unable to judge whether his wool has improved or not since the preceding summer. On this account it would be highly desirable that some easy and correct method of admeasurement by the micrometer could be invented, which might enable the observer to decide this with certainty. Mr. Daubenton employed a graduated scale, adapting it to the eye-piece of a compound microscope; but his method does not admit of accuracy. Mr. Luccock made use of a more simple instrument, which we have seen; it consisted of a lens about half an inch in focal length, adjusted to a graduated scale. On this scale a number of fibres were stretched and compressed by a slider and screw into a given space; the filaments covering this space were then counted by the aid of the lens, and a number of admeasurements being taken of the same sort, the mean of the whole was supposed to give the correct diameter of the filament. In this method, however, some of the filaments must unavoidably overlap part of the others, on which account a greater number will be seen in a given space than there would be were the whole diameter of each fibre visible. The error resulting from this may be stated at one-fifth. Thus Mr. Luccock makes the best English wool to measure the fourteen-hundredth part of an inch, which is finer than the best Spanish, as measured by Dr. Parry, by a more accurate but more laborious method. According to Mr. Luccock, a sample of moderately fine Spanish wool reached to the sixteen-hundredth part of an inch; according to Dr. Parry, the very best Spanish is not smaller than the fourteen-hundredth part of an inch.

With the above deduction of one-fifth, which we believe to be a near approximation to correctness, the diameter of the fibres of the best English wool, as sorted in the usual method, will be nearly as follows:

horizontal position for the microscope will be the most convenient, illuminating the object with a lamp and lens. In this way, the apparent diameter may be greatly increased, and we think the observations might be made with greater ease and accuracy.

By the above method the diameter of very minute filaments may be ascertained, and minute differences detected, which the unassisted eye is unable to detect. We are aware, however, that it requires some address and time to enable the observer to manage the instrument, on which account it cannot, we fear, be made generally useful.

The following admeasurements of different fine wools were taken with Dr. Parry's instrument; the first column represents the outward end of the filament, the second the middle, and the third the bottom, in fractional parts of an inch; the latter column the mean of ten filaments of the same wool.

TABLE of comparative Diameters of the Filaments of various Clothing Wools, by Dr. Parry.

	Outward End.	Middle.	Inner End.	Mean.
Spanish Ewe - - -	$\frac{1}{1037}$	$\frac{1}{1433}$	$\frac{1}{1488}$	$\frac{1}{1770}$
Lasteria Pile - - -	$\frac{1}{1136}$	$\frac{1}{1718}$	$\frac{1}{1772}$	$\frac{1}{1764}$
Ewe - - - - -	$\frac{1}{1038}$	$\frac{1}{1282}$	$\frac{1}{1220}$	$\frac{1}{1254}$
Coronet Pile - - -	$\frac{1}{1241}$	$\frac{1}{1228}$	$\frac{1}{1277}$	$\frac{1}{1235}$
Native Merino Ram -	$\frac{1}{1136}$	$\frac{1}{1234}$	$\frac{1}{1335}$	$\frac{1}{1234}$
Saxon - - - - -	$\frac{1}{1270}$	$\frac{1}{1191}$	$\frac{1}{1184}$	$\frac{1}{1202}$
Pictet's Merino Ram	$\frac{1}{1133}$	$\frac{1}{1278}$	$\frac{1}{1178}$	$\frac{1}{1195}$
Best Negrette Pile -	$\frac{1}{1173}$	$\frac{1}{1173}$	$\frac{1}{1222}$	$\frac{1}{1189}$
Alva Pile - - - -	$\frac{1}{1035}$	$\frac{1}{1234}$	$\frac{1}{1276}$	$\frac{1}{1176}$
Rambouillet Ewe - -	$\frac{1}{1087}$	$\frac{1}{1131}$	$\frac{1}{1228}$	$\frac{1}{1130}$
Imperial Pile - - -	$\frac{1}{1118}$	$\frac{1}{1037}$	$\frac{1}{1067}$	$\frac{1}{1131}$
Morre - - - - -	$\frac{1}{1170}$	$\frac{1}{1011}$	$\frac{1}{1000}$	$\frac{1}{1121}$
Ryeland - - - - -	$\frac{1}{1033}$	$\frac{1}{1156}$	$\frac{1}{1133}$	$\frac{1}{1124}$
South Down - - - -	$\frac{1}{1038}$	$\frac{1}{1141}$	$\frac{1}{1174}$	$\frac{1}{1140}$
Anglo Negrette Ram	$\frac{1}{1015}$	$\frac{1}{1010}$	$\frac{1}{1138}$	$\frac{1}{1037}$
Negrette Ram, Marquis of Bath - - - - -	$\frac{1}{805}$	$\frac{1}{973}$	$\frac{1}{1217}$	$\frac{1}{1031}$
Charenton Ram - - -	$\frac{1}{1034}$	$\frac{1}{977}$	$\frac{1}{1000}$	$\frac{1}{1003}$
Ryeland Ram - - - -	$\frac{1}{844}$	$\frac{1}{938}$	$\frac{1}{1086}$	$\frac{1}{980}$
Cape, 4th Cross - - -	$\frac{1}{858}$	$\frac{1}{998}$	$\frac{1}{970}$	$\frac{1}{977}$
Wilts Ewe - - - - -	$\frac{1}{873}$	$\frac{1}{791}$	$\frac{1}{850}$	$\frac{1}{806}$

Long Wool, or Combing Wool, being prepared for spinning by a process entirely different from that of short or clothing wool, and the pieces made from it being finished in a very different manner, the qualities most required in this kind of wool are length and soundness of the staple, without which the fleece is unsuited for the comb. The fineness of the hair is a secondary quality, required only in certain kinds of goods. The wool-comb is an instrument of simple construction, consisting of a wooden handle, with a transverse piece or head, in which are inserted three rows of long steel teeth. The wool, which is to be combed after being clean scoured, dried, and oiled, is first drawn upon these teeth with the hand, until the comb is sufficiently loaded. It is then placed on the knee of the comber, and another comb of a similar kind is drawn through it, and the operation is repeated till all the hairs or fibres are combed smooth in one direction. This operation requires considerable strength, but the comb being previously heated, and the wool thoroughly oiled, facilitates the process. When completed the

combed wool is drawn off with the fingers, forming what is called a *sliver*; the shorter part of the wool sticks in the teeth of the comb, and is called the *noyl*: this is fold to the clothiers.

From the above description, it is evident that if the staple of the wool be not found, the greater part of it will be broken by the process of combing, and form noyls. The staple must also have a sufficient degree of length for the combs to operate upon it. Length and soundness of the staple are therefore the most essential and characteristic qualities of combing-wools.

Long wools may be classed into two kinds: first, those suited for the manufacture of hard yarn for worsted pieces; and second, those suited for the manufacture of soft yarn used for hosiery. The former require a greater length of staple than the latter. The first may therefore be called long combing-wool, and the latter short combing-wool; between these there are gradations of wool, which may be applied to either purpose.

Long combing-wool should have the staple from six inches to eight, ten, or even twelve, in length. Before the recent improvements in spinning by machinery, a very great length of staple was considered as an excellence in long combing-wools; and on this account the hog-wool, or the first fleeces from sheep which had not been shorn when lambs, was more valuable than the wether wool from the same flock, and bore a higher price than the former, by at least fifteen per cent. Since that time the wether wool has risen in relative value on account of the evenness of the staple, each lock being nearly equally thick at both ends; but the staple of hog-wool is pointed, or what is technically called *spirey*. Eight inches, if the wool be found, may be regarded as a very proper length for heavy combing-wools. The longer stapled wool was formerly worked by itself, and used for the finer spun yarn, or mixed in small quantities with the wether wool, to improve the spinning. It is found that an equal length of staple contributes to the evenness of the thread when spun by machinery, and a very great length of staple is rather injurious than otherwise in the process of machine spinning. To the wool-grower, however, it must always be desirable to increase the length of his heavy combing fleeces, as he thereby materially increases the weight; and we have not yet learned that the price has ever been reduced on this account, for if the wool be too long for some branches of the worsted manufacture, there are others in which it may be worked with advantage.

The length of the staple may be increased by a plentiful supply of nutritious food. The same effect may also be produced by letting the wool remain a longer time on the sheep before it is shorn. We have seen a staple of Lincolnshire wool which was twenty inches in length: it had grown two years without shearing. This, however, would be unattended with any advantage to the grower. The more frequently sheep are shorn, provided the wool is sufficiently long, the greater will be the weight grown in a given time on the same animal; for, from observations which we have made, we are satisfied that wool is grown more rapidly immediately after the sheep are shorn than at any other time. Length of staple in wool depends primarily on the breed, but may be more affected by culture than many other qualities of the fleece. The soundness of the staple may be easily judged of by pulling both ends of it with the fingers with considerable force. In weak or unsound wool the staple easily breaks in one or more parts, and on observing it, it will be seen that the fibres are much thinner in the part which breaks. This is occasioned either by a deficient supply

ly of food, by disease, or by inclement seasons, which cause a stoppage in the growth of the fleece. This goes on to a greater or less degree. In some instances, the stoppage has been so entire that the upper part of the staple is nearly separated from the lower, and is only connected with it by a few filaments: in such cases, the stoppage has continued for a considerable time, and the bottom part of the staple may be considered as a new fleece, protruding the old one from the skin. Connected with the soundness of wool, there is another property required; this is, that the staple be free and open, or that the fibres shall not be matted or matted together; an effect which takes place frequently when the wool is unfound. It is in fact a natural felting of the wool on the back of the animal, when by any cause it has ceased to grow. Sometimes the lower part of the fleece next the skin will be so completely matted as to form a substance nearly as hard as a hat, and will hold to the skin by a few hairs only. These are called cotted fleeces; all approach to this state is peculiarly injurious to combing-wools. The wool-buyers generally throw out the cotted and unfound fleeces when they pack the wool from the grower, and buy them at a very reduced price. The softness of combing-wool, though of less importance than in clothing-wool, yet enhances its value, as it is found that such wool makes a closer and softer thread, and in every process of the manufacture finishes more *kindly*. Combing-wools grown on light calcareous soils are deficient in this respect; such are the combing-wools of Oxfordshire and the Cotswold hills, which are formed of that species of lime-stone called oolite, or roe-stone. A copious supply of the yolk is necessary to the healthy condition of the fleece, and as this in many locks is nearly equal in weight to the wool, the fleeces contain from six to eight pounds or more of it before they are washed, for in the unwashed state they often weigh eighteen pounds in many of the long-woolled flocks in England.

The whiteness of the fleece is less important in the long combing than in clothing wool, provided it be free from grey hairs. The latter circumstance does not frequently occur in combing-wools. There is, however, a peculiar colour communicated by the soil, which is sometimes so deep as to injure the wool for particular uses, and what is of more importance, there is a dingy-brown colour given to the fleece by impoverished keeping or disease, which is called a *winter stain*; it is a sure indication that the wool is not in a thoroughly sound state, and such fleeces are carefully thrown out by the wool-sorter, being only suited for those goods which are to be dyed dark colours.

The fineness of heavy combing-wool is of less importance than the other qualities. In every fleece of this kind there will be a certain small portion of short clothing-wool on the flanks, the belly, the throat, and the buttocks. The clothing-wool from such fleeces is not often divided into more than two or three low sorts, and the combing-wool is seldom thrown into more than four sorts, that is, two sorts of the hog-wool, and two sorts of the wether-wool, of which three-fourths, if the fleece be good, will form the best sort in each.

There is, however, a fine long combing-wool which is required for bombazines and the finer kinds of worsted goods; this is most frequently selected from the longer parts of clothing fleeces, and admits a division into four or five sorts, the finest being equal in hair to that of the head or super in clothing-wool; whereas the best sort of the common heavy combing-wools seldom ranges higher in point of fineness than the coarsest sort of clothing-wool above the breech locks; *viz.* the low abb and the livery.

Short combing or hosiery wool requires a different length of staple, according to its fineness: for the better sorts, the staple should not be shorter than four or five inches; the lower sorts may range as high as eight inches. A greater length than this is not desirable for any kind of soft worsted. What has been said of the soundness and fineness of staple required for long combing-wool, applies equally to the hosiery wool, but in this the fineness of the hair and softness are of more importance. Most of the fleeces which yield fine combing-wool produce nearly an equal quantity of short wool, which is thrown in the same manner as the regular clothing sorts. The combing sorts for the hosiery are generally called,

Super matching,
Fine matching,
Fine drawing,
Altered drawing,
Brown drawing,
Saycast.

The names of these sorts derive their origin from ancient processes of the manufacture, with which we are unacquainted at present. The lower sort, or saycast, was probably at first the long coarse combing-wool, thrown out for the manufacture of says, of which we have frequent mention in the earliest history of the woollen trade in England. The relative value of these sorts, compared with each other, varies according to the demand for the finer or coarser kinds of hosiery, and is also affected by the clothing trade. When any clothing sort which ranges in fineness with one of the combing sorts is in great demand, the wool-sorter will break down the shorter combing-wool of this sort, and throw it to the clothing-wool, which enhances the price of the former by making it scarce. The fineness of these sorts out of the best combing-wools, stated numerically, as compared with clothing sorts, will be nearly as under, in the fractional parts of an inch.

Super matching	-	-	$\frac{1}{750}$
Fine matching	-	-	$\frac{1}{780}$
Fine drawing	-	-	$\frac{1}{700}$
Altered drawing	-	-	$\frac{1}{800}$
Brown drawing	-	-	$\frac{1}{770}$
Saycast	-	-	$\frac{1}{750}$

Most of the best sorters throw out the hog combing-wool from the best sorts, making a superfine hog for the bombazine trade, hog-wool being less suitable for the hosiery, which does not require yarn so finely spun as for hard yarn.

As all the different sorts of short combing-wool, together with several sorts of clothing-wool, will frequently occur in one English fleece, it is obviously the interest of the grower that his fleece should produce as great a proportion of the best sorts as can be done without materially diminishing the weight.

Skin Wool, or Pelt Wool, is the wool separated from the skins of slaughtered sheep by the fellmonger. The quantity of this wool, in a country like England, where so much animal food is consumed, is very considerable, and has been estimated at near 50,000 packs of 240lbs. *per annum*, for England and Wales. Soon after shearing, the skin-wool is too short to be worked by itself, and is generally kept and mixed in with the longer wools. The process by which wool is separated from the skins has a tendency to make it hard, and destroy or injure its felting or milling property, on which account short-skin wools are seldom used for the manufacture of cloth, but more generally for flannels, serges, and those kinds of goods which require little or no milling;

the finest kinds are much used for stockings made of yarn from carded wool. In the spring, when the wool on the skins has acquired a considerable length, it is thrown into combing sorts; the finer kinds are used for knitting hosiery yarn, and the coarser for hard yarn for the warps of serges and other goods, having a warp of combed and a weft of carded wool. The value of skin-wool is seldom equal to that of fleece-wool of the same degree of length and fineness, owing to the felting property being injured, which renders it more unfit for the manufacture of woollen cloth.

Lamb's Wool.—The wool of the lamb is, with certain exceptions, softer than that of sheep's-wool, from the same flocks. It possesses the property of felting in a remarkable degree, and on this account is principally manufactured into hats, except skin lamb's-wool, which losing its felting property in a great degree, is employed in the manufacture of flannels and woollen yarn for lamb's-wool hosiery. In the northern parts of Europe, the lambs of some of the breeds of sheep possess a fleece so delicately soft, that it constitutes a most valuable fur, being dressed on the skin, and used as a costly article of attire. According to Pallas, the inhabitants of the Ukraïn and Podoli, as soon as the lamb is dropped, (which comes into the world with a pretty wavy skin, even without the assistance of art,) to augment its beauty, and make it bring a higher price, sew it up in a sort of coarse linen shirt, so as to keep up a constant gentle pressure on the wool, pouring warm water over it every day to make it soft and sleek; only letting out the bandage a little from time to time as the animal increases in size, but still keeping it tight enough to effect their purpose, which is to lay the wool in beautiful glossy ringlets, and thereby produce a delicate species of fur in great request for lining clothes and morning-gowns. By this treatment, the staple of the fine soft wool which rises in the infancy of the lamb takes a handsome arrangement; and the animal is killed younger or older according to the species of fur intended to be produced; from a short glossy nap, like satin, only fit from its thinness for the purpose mentioned above, to a warm thick fur for a winter great-coat. The first of these furs in estimation and price is a fine black, that looks like silk damask; an inferior black fur comes next, much thicker, used for *pelisses*, or *shubes*, as the upper winter garb worn out of doors is called; and the least in estimation is the whitest, except it be of a very pure colour and silky appearance, where it is a rival to the first; especially for night-gowns, a very common dress both morning and evening amongst the Russians; particularly in the interior parts of the empire.

The Boucharian sheep, as described by Pallas, grows a compact, soft, and elastic wool, which is elegantly formed into frizzled ringlets. In the lamb, the wool is formed into delicate little circular waves, as if pressed close to the skin by art; but when taken from the mother, or killed immediately after birth, they are still more beautiful, and often elegantly marbled with feathered waves, like silk damask. These three furs are the finest and most precious of the kind known to Europe and the East; they are brought to us by the Boucharian Tartars and Persians, who sell them dear. The most prized are, the *blue*, the black, and the silver grey; but of the *unborn lamb-skins*, as the fine glossy thin furs are called, which so much resemble silk damask, the fine black is dearest and most esteemed. To obtain these valuable furs, the Boucharian Tartars purchase whole flocks of male lambs just dropped from their mothers: as to kill a female till past the age of breeding is held as a kind of crime by all Tartar hordes; such is their reverence for an animal which constitutes their greatest riches, and the propagation and care of

which are the great business of their lives; so that all the fur we see of this species sold by the Tartars are from young rams. The Boucharians are of opinion, that art is necessary to preserve these furs in their greatest beauty; and under that idea, keep the lambs under shades, &c. during the meridian ardour of the sun; but Dr. Pallas has reason to think, that these precautions are useless, as he observed that the same variety of sheep produced the same fine hues equal in every respect, without any sort of care, in the hands of the Kirguite Tartars.

It is very remarkable that the lamb's-wool, in many of the Merino flocks, is coarser than the sheep's-wool. In some of the flocks, the lambs are at first covered with coarse hair, which falls off afterwards, and they produce the finest wool.

Wool from other animals besides the sheep is employed in manufactures, and spun and woven into fabrics of different kinds, either unmixed or mixed with sheep's-wool. The goats of Thibet, which grow the fine shawl wool, produce it as a fine down at the bottom of the long coarse hair, with which the animals are covered. Many of the common goats in Europe grow a similar down, which, by cultivation, might become a valuable article of commerce. It is not, however, yet clearly ascertained, whether the shawls and shawl cloth of India are all manufactured from goat's-wool; part of it appears to be made from sheep's-wool peculiarly soft and fine. The Angora goat grows a hair extremely fine and silky, which is much used in some of the French worsted goods mixed with silk. This goat is properly a long-woolled animal. Dr. Anderson says, that the Angora goat will prosper and preserve its peculiarities in France and Sweden. The wool of the vicunna, called Vigonia wool, is generally of a reddish-fawn colour; it is peculiarly soft and silky, but intermixed with long coarse hairs, which are very difficult to separate. (See VICUNNA.) From the lama and pacos of Peru a stronger and longer stapled wool is obtained, which is sometimes white. Under a liberal government which protected and encouraged commerce, we have no doubt the fleeces of these animals might be greatly improved, and would become an article of great value. The wool from the yak of Tartary, and the mulk ox of Hudson's bay, has yet received little attention. We have seen stockings made of the latter, and which are worn in that country; the wool was soft but not fine, and much intermixed with long coarse hairs.

The quantity of sheep's-wool annually grown in England and Wales was estimated, by persons in the wool trade examined before the house of commons in the year 1800, at six hundred thousand packs. Mr. Luccock, in his Treatise on Wool, seems to consider this estimate as greatly exceeding the real amount, and has given an estimate founded on the supposed extent of surface pastured by sheep, and the quantity of sheep *per acre* in each county. This table we subjoin, as the only attempt that we know of to determine the question on certain data; though we consider it only as an approximation to truth, and are inclined to believe that the quantity is under the real amount. Such is also the opinion of the most intelligent persons in the wool trade, whom we have had an opportunity of consulting.

From this table, it will appear that the total amount, including skin-wool and lamb's-wool, is somewhat short of four hundred thousand packs, which is probably one-fourth below the true quantity, could it be ascertained. Mr. Luccock is inclined to believe that the flocks of sheep in England and Wales are not so numerous as formerly, but he says those of Ireland and Scotland are rapidly increasing. Even in England and Wales, he says, we have

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more than three millions of acres capable of being improved, and carrying a more numerous stock. We have two millions of sheep whose fleeces are scarcely wool, and which might be brought to contribute their share to support the woollen manufacture, and to increase the wealth of the country.

It may be proper to remark, that the quantity of wool grown annually in England is more variable than is generally supposed, owing to the variable temperature of our climate. In long-continued and severe winters, the sheep not obtaining the same quantity of food, and being also rendered less vigorous by the cold, do not grow so much wool as in milder seasons. The difference between the weight of the fleeces grown in severe and in very mild seasons, may be stated at one-fifth of the whole annual clip: indeed we believe it exceeds that proportion. About the year 1700, the annual value of English wool was estimated at two millions sterling. If we suppose the average price at that time to have been eight-pence *per* pound, or eight pounds *per* pack, this will make the total weight of wool two hundred and fifty thousand packs. Indeed when

we consider the improved state of our agriculture, the great increase of our population, and of our woollen exports, we may fairly state the present weight of wool grown to be double the amount of what it was at the period referred to. In a subsequent part of this article, it will be seen that the cloth manufactures of Yorkshire, principally from English wools, have increased eight-fold in the last eighty years; and though the woollen manufactures have removed from some other situations, yet the great increase on the whole in England cannot be doubted. Since the date of Mr. Luccock's table in 1805, in consequence of the high price of long combing-wool, the growers have paid more attention to the weight of their fleeces; and many who had rendered their fleeces lighter by exchanging the Lincolnshire for the Leicester breeds of sheep, have since been reverting to the former breed, or rather to a mixed breed, endeavouring to combine the improved form of the Leicester sheep with the heavy fleece of the Lincoln. The quantity of long combing-wool grown annually is greater than it was even ten years since; the high and increasing price and demand operating naturally as a premium for its cultivation.

TABLE I.—Shewing the Produce of English Long Wool.

District.	County.	No. of Acres.	No. of Sheep.	Weight of Fleece.	No. of Packs.
Teeswater -	{ Durham - - - - -	100800	67200	9	2520
		61250	14310	8	477
		127680	84000	8	2800
		413875	1241625	9	46561
Lincoln -	{ Lincoln rich land marshes - - - - - miscellaneous land	175000	87500	8	2916
		758485	505657	8	16855
		55428	38500	7	1223
		187600	41688	8	1390
		87500	87500	7	2552
		398650	380528	7	11100
		560000	640000	6	16000
Leicester -	{ Rutland - - - - -	117000	114000	5	2370
		182875	160000	5	3333
		14000	3720	7	113
		46920	185000	7	5400
Kent -	{ Romney Marsh Other Marshes - - - - -	65000	108330	7	3160
		387500	193750	8	6458
Devonshire -	South Hams - - - - -	200000	200000	8	6666
Cotswold -	Gloucester - - - - -	200000	200000	8	6666
		3939563	4153308		131794
Slaughtered		1176770 Sheep			
		196128 Producing long-skin wool		5720 Packs.	
		Carrion wool		286	
				5434	
Neat Total -				137228	

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TABLE II.—English Short Wool.

District.	County.	No. of Acres.	No. of Sheep.	Weight of Fleece.	No. of Packs.
Norfolk	Norfolk	1260572	683704	2	5697
	Suffolk	817000	497000	2½	5176
	Cambridge	817600	67744	4	1128
	Huntingdon	144000	108000	4½	2000
	Bedford	268800	204000	5	4250
	Essex	778400	519000	3	6486
	Suffex Downs	211200	316800	2	2640
	Low Land	623840	547000	3	6837
	Kent	728000	524475	3¼	7000
	Hampshire	774900	516600	3	6457
	Isle of Wight	87500	61000	3¼	800
	Surrey	327600	283000	3	3540
	Wiltshire Downs	437000	583500	2¾	6684
	Pasture	235000	117500	3	1460
Wiltshire	Berkshire	408800	306600	3¼	4151
	Oxford	380730	304584	Various.	5303
	Bucks	408800	222968	3	2787
	Herts	369600	277000	4½	5297
	Middlesex	76000	45000	4	750
	Dorset	700000	632240	3¾	9880
	Devon	873700	436850	4	7280
Western	Cornwall	812000	203000	4	3382
	Somerfet	851200	500700	4½	9338
	Gloucester	528000	355000	Various.	5400
	Hereford	672000	500000	2	4200
	Monmouth	322625	177619	Various.	1431
	Worcester	369600	330504	3½	4820
	Shropshire	739200	422034	2½	4397
	Stafford	549360	183120	2	1526
	Warwick	365925	182962	3	2287
	Leicester	50000	20000	3½	291
Hereford	Lincoln	309120	123648	5½	2833
	Nottingham	435680	255147	Various.	4112
	Derby	553280	362400	3	4530
	Chester	588000	65000	Various.	926
	Lancaster	952000	310000	3½	4522
	York West Riding	1429250	383122	Various.	6678
	East Riding	454720	306240	5	6380
	North Riding	1200000	365326	Various.	5939
	Westmoreland	431200	378400	3½	3262
	Cumberland	856800	378400	3¾	5915
	Durham	414400	159385	5	3320
	Northumberland	1108800	538162	5½	12333
Welsh	North Wales	2035200	683040	2	5692
	South Wales	2284800	571200	1½	3570
	Isle of Man	-	-	-	-
		28412202	14854299		202737

Packs Skin Wool.

Slaughtered	4221748 sheep	$\frac{3.25}{2}$	28580
Carrion	211087	-	1429
Slaughter of long-wool sheep	980642	3	12258
Carrion of ditto brought forward	-	-	286
			42553
Total of short wool			245290
Ditto long ditto			137228
Wool from lambs slaughtered	-	-	2918
Ditto shorn	-	-	7800
			10718
Grand total			393236

WOOL.

N.B.—The average fleece of England, } nearly - - - - - }	lbs.	oz.
Do. ————— short wool	4	8
Do. ————— long wool	3	4
Do. ————— stock per acre in } England - - - - - }	7	10
Do. ————— do. long wool - - - }		$1\frac{1}{2}$ sh.
Do. ————— do. short wool - - - }		$2\frac{1}{2}$ sh.
Do. ————— produce per acre } long fleece wool - - - }	8	0
Do. ————— do. short do. - - - }	1	5
Do. ————— do. long skin wool - - }	0	5
Do. ————— do. short do. - - - }	0	4
Do. ————— do. skin wool of } the kingdom, nearly - - - }	0	5

The wool of Scotland may, perhaps, be estimated at 70,000 packs, of which the greater part, particularly that grown in the Highlands, is of the very coarsest kind. Of the quantity of wool grown in Ireland, we can form no correct estimate, but it cannot be great. From the returns at the Custom-house, it appears that the quantity of wool imported from Ireland and the Isle of Man in 1816 amounted to about 2600 packs; whilst the value of woollens imported from England was upwards of 500,000*l.* sterling. The woollen and worsted manufactures in Ireland are no where on an extensive scale; perhaps 60,000 packs are the full amount of the wool annually shorn in Ireland: this was the amount stated about a century since.

The quantity of wool imported into England may be seen from the following return at the Custom-house for the year 1817, amounting to about thirty thousand packs. The qualities we have annexed in the last column.

An Account of the Quantity of Sheep and Lamb's Wool imported into Great Britain, in the Year ending 5th January 1817; distinguishing the Countries from whence imported.

Countries from whence imported.	Year ending 5th Jan. 1817.	Quality.
	lbs.	
Russia - - - - -	228,673	Coarse.
Denmark - - - - -	80,646	Principally coarse.
Iceland and Feröe - - -	33,395	Coarse.
Prussia - - - - -	16,712	Fine clothing-wool.
Germany - - - - -	2,816,655	Principally ditto.
Holland - - - - -	143,390	Ditto.
Flanders - - - - -	77,625	Ditto.
France - - - - -	221,595	Ditto.
Portugal, &c. - - - - -	493,277	Ditto.
Spain - - - - -	2,958,607	Ditto.
Gibraltar - - - - -	25,692	Coarse.
Italy - - - - -	108,234	Principally fine.
Turkey - - - - -	26,821	Fine.
Ireland and Isle of } Man (produce) } - - - - - (foreign) }	600,377	} Various, none } very fine.
New Holland - - - - -	13,611	Fine Merino.
Cape of Good Hope - - -	9,623	Ditto.
United States of Ame- } rica - - - - - }	43,465	} Various.
Spanish colonies in } South America - - - }	206,454	} Ditto.
Brazil - - - - -	5,512	Ditto.
British West Indies - - -	6,329	Ditto.
Total - - - - -	8,117,864	

The whole of the imported wool, with scarcely an exception, is worked on the card, none of it being suited for the comb. The coarser kinds are principally employed for carpets, &c.; and the fine from Spain, Germany, Portugal, and France, supply our manufactures of superfine broad cloths, cassimeres, &c. So large a portion being of the finer kinds, the total value cannot be less than one million and a half pounds sterling.

Wool of New Holland.—The annual value and amount of the fine wool imported into England for our own manufactures being so great, we must surely applaud the meritorious exertions of those who attempt to supply the demand with the produce of our own country, or of our dependent colonies, and more particularly if they can raise this supply from parts where no wool was before grown. In this view, it cannot fail to be highly interesting to learn, that the exertions of one enlightened agriculturist have been eminently successful in spreading over an immense region dependent on England the very finest-woolled sheep, where the soil had never before yielded any produce serviceable to civilized man.

John Macarthur, esq. descended from an ancient family in Argyleshire, captain in a regiment then commanded by general Grose, went to New Holland in 1789. Fortunately for the future prosperity of the colony, his active spirit of inquiry and enterprise led him to direct his attention to the natural advantages which the soil and climate presented to the agriculturist, and having by purchase and grants obtained a considerable tract of country, he quitted the service in 1793, and commenced his farming operations. His stock at first consisted only of a few oxen and thirty Bengal ewes, growing a coarse kind of wool or hair. About the year 1795, he obtained from captain Kent, of the Royal Navy, one Merino ram and two ewes, purchased from the Dutch governor of the Cape of Good Hope. With these he began to cross his coarse-haired sheep, and to select the finest-woolled progeny to breed from. Having occasion to return to England in 1802, he brought over specimens of his wool, which were shewn to a body of the clothiers from the west of England, then in London on public business, who were so sensible of the advantages which might result from encouraging the growth of fine wool in the colony, that they presented a petition to the privy council, by whom Mr. Macarthur was examined. His plans being approved, the privy council recommended the secretary of state for the colonies to give him an additional grant of land, in a tract of country, from its fertility, called the cow-pastures, forming part of Camden county. On his return he took with him three Merino rams and two ewes, purchased from his majesty's flocks; and thus encouraged, he proceeded with rapid steps in the increase and improvement of his flocks, the climate being every way suited to secure the healthy condition of the sheep, and preserve the fineness of the wool.

The numbers increase four-fold every five years, so that his flocks already amounted to about four thousand sheep and lambs, including the fine and mixed breeds, when the unfortunate disputes with governor Blight, and the subsequent arrest of the latter, obliged Mr. Macarthur once more to return to England, and in some degree interrupted the progress of improvement. In 1817 his flocks had increased to about seven thousand, and the wool which has been sent to this country at different times, is become an important source of profit, the better sort being equal to the best Merino piles from Spain or Saxony. What we have seen more nearly resembles the latter, and were they both in the same state of cleanness, the most experienced eye could not discern any difference between them in fineness of the hair, length of staple, soundness, colour, or other properties.

The wool has been hitherto washed on the sheep's back in the English method, by which it is not rendered so clean as by the Spanish or German mode; but making allowance for the additional waste, its value is equal to that of the very best Merino wool imported from any part of Europe.

The quantity imported this year is about eighteen thousand pounds weight, and a farther arrival is expected. The laudable example of Mr. Macarthur has been followed by other persons in the colony, and the total amount of wool sent from thence this year is about fifty thousand pounds weight; and such is the spirit of agricultural improvement, that at the annual sales of sheep established by Mr. Macarthur, rams and ewes have been sold at from ten to thirty guineas each. Though the absence of Mr. Macarthur impeded the progress of improvement, yet this will be more than compensated by the valuable information he has obtained with respect to the management and improvement of his flocks, from observations made on the continent; and he has further benefited the colony by taking back with him a selection of olive-trees, vines, and oranges. The dryness and mildness of the climate of New Holland, and the almost total absence of briars and underwood, are extremely favourable to sheep. His stock is divided into flocks of about four hundred, with shepherds and Spanish dogs to each. Under these propitious circumstances, and as the flocks double in number every thirty months, we may anticipate, that in the course of twenty or twenty-five years, the importation of fine wool from this colony will be fully equal to the total amount at present imported into England from all the different countries of Europe. It might repay the exertions of this enlightened agriculturist, and of the British government, could they procure from India the animals, whether sheep or goats, which yield the peculiarly soft wool for shawls. This would be a most valuable article, and is much wanted by our manufacturers.

There can scarcely be a doubt, that under the favourable climate of the British settlements in New Holland, all the Asiatic wool-bearing animals, particularly those of Cashmere and Thibet, might be introduced with every prospect of success. The coarse wool grown in the colony is chiefly manufactured in the country for domestic use. It is estimated that there are at present sixty thousand sheep in the colony, and a little perseverance and attention would suffice to change the coarse-woolled breeds into finer ones; a change which is at present rapidly taking place, and deserves the greatest encouragement, as wool is the only article of produce which the colonists have at present to export in exchange for British manufactured goods.

The Improvement of Wool depends primarily on attention to the breed of sheep, but there are various circumstances of soil, climate, and food, which are important to be regarded. The experiments that have been made in various parts of Europe within the last half century, have sufficiently removed the prejudice that long prevailed, respecting the impossibility of growing the finest clothing-wool in almost every part of the globe where sheep will subsist and thrive. It is different with the long combing-wools, to grow which in perfection, luxuriant pastures seem absolutely requisite, and these cannot be obtained under a parching sun, nor could the animal subsist in tropical climates, covered with such a load of wool as is grown on our sheep in Lincolnshire. Under such circumstances, an entire change seems to take place in the animal system; the long-woolled sheep become diseased and feverish, and only recover by casting the fleece, which is replaced by a coat of short hair. The rich pasture in England, and the opposite coasts of Flanders, seem more favourable to the growth of heavy combing

fleeces, than any other country in the known world; and the Leicestershire and Lincolnshire sheep seem every way well suited to these pastures, and the prices of the wool obtained at present are sufficient to secure attention to its cultivation. At one period, indeed, during the American revolution, the price of long combing-wool not being more than about three-pence *per* pound, the growers turned their attention principally to the improvement of the carcase, and neglected the weight of the fleece. At present the price is about eighteen-pence, and the average weight being about eight pounds, the wool forms an important object, and the growers are endeavouring to increase the weight of their fleeces. For the common purposes of the worsted manufactures, this wool is so well suited as to leave nothing further to be desired; and it is this kind which foreign manufacturers are so desirous to obtain from us. In many situations, however, where heavy long-woolled sheep are introduced, and where the soil is not sufficiently rich to grow it in perfection, it would be possible to grow a fleece weighing five or six pounds of very fine combing-wool, by crossing the long-woolled ewes with the Anglo-Merino rams. The increasing demand for finer goods, and the great improvement made in the spinning of combing-wool by machinery, make such a change desirable where the pastures are not sufficiently rich to bear the heavy long-woolled breeds of Leicester and Lincoln.

In many cold and exposed situations it would be desirable to provide better shelter for the flocks; and the practice of *grazing*, hereafter described, might be introduced with great advantage, and would tend to preserve the sheep and improve the quality of the wool.

The experiments made on the fine-woolled sheep on a large scale in different parts of Europe, prove that the peculiarities of food and climate have comparatively small influence on the quality of clothing-wool, and that it may be grown equally fine in situations where the sheep are confined and kept on dry meat a great part of the year, as in Saxony, Sweden, and Denmark. It may also be grown in the richest pastures, provided the pastures be over-stocked, to keep the herbage bare. There cannot, however, be a doubt, that a dry light soil, particularly in the moist climate of England, is most favourable to the health of the sheep, and to the quality of the wool.

The experiments that have been made in England on the Merino sheep have not been so successful as in other countries, principally arising from two causes.

In the first place, the demand for meat in England will always make the wool but a secondary object with the grazier, and no cross of the Merino sheep with the English has yet produced a race that equal in symmetry of form the South Down sheep, or that will produce the same quantity of meat to the butcher in the same space of time, and with the same food. In the second place, the mode of washing the Merino and Anglo-Merino wool in England will, so long as it is practised, prevent the wool from obtaining its proper value in the market. From the great quantity of natural yolk or grease in the Merino fleece, it is impossible to wash the wool on the sheep's back by mere immersion in water. In Spain no attempts are made to wash the wool upon the sheep's back, but all the fleeces of a pile are regularly sorted, and the different sorts scoured and dried before the wool is packed. But where the quantity of wool which any one grower possesses is small, as in England, it would not answer to send for wool-sorters from a distance; and to wash the wool before it is sorted, would so intermingle the fine with the coarse locks, as to render the regular sorting extremely difficult and expensive. In Saxony

Saxony and Sweden the wool is washed on the sheep's backs. The following account of the process is thus described by baron Schulz. The sheep are first washed with one part clear ley, and two parts lukewarm water, and then in another tub with less ley in the water; after which the sheep are washed, laying them always on their backs, with their heads up, in a tub with clean water; and lastly, there is poured on the sheep, when standing on the ground, a sufficient quantity of water, which is as much as possible squeezed out of the wool. The sheep are afterwards driven into an unpaftured meadow adjoining, and remain there, to prevent their soiling themselves in the sheep-house. They remain there a day and a night, or longer, till the wool be dry, which in fine weather will be in three days. Some persons wash their sheep twice, but the wool becomes harder in consequence of it, and has a greyer appearance.

The great quantity of greafe which the finest Spanish wool contains at the first washing mixes with the ley-water, and makes it quite soapy; but this greafe is wanting in the second washing, so that the water is not in the least softened. Some mode of washing like the above must be introduced in England, before the manufacturer will encourage the Anglo-Merino wool; for after his purchase, when he thinks he has obtained sufficient allowance in the price to cover the waste, he is generally much disappointed in finding the loss in the manufacture so greatly to exceed his expectation, and he is deterred from making a second trial.

In the northern counties of England, and in Scotland, a practice has long prevailed of greasing the sheep with a mixture of tar and butter, to preserve the animal from the effects of moisture, and the inclemency of the weather in hilly and exposed situations. This practice seems at present peculiar to Britain, but the ancients evidently made use of mixtures of the dregs of olive wax, tar, wine, and other ingredients, to protect the skin of sheep after shearing, and to soften and improve the wool. Such was the practice of the Italian shepherds, as described by Virgil:

“ Aut tonsum tristi contingunt corpus amurca,
Et spumas miscent argenti vivaque sulfura,
Idæalque pices et pingues unguine ceras
Scyllamque helleborosque graves nigrumque bitumen.”
Georg. lib. iii.

That this practice was extremely beneficial in warm climates, by protecting the skin of the sheep from insects after shearing, and by keeping the wool in a soft state, cannot be doubted.

The practice of greasing the sheep in Scotland, and the northern counties of England, with a mixture of tar and butter, seems to have been introduced merely to preserve the sheep, and was generally supposed to be injurious to the wool. Indeed the great proportion of tar, too frequently employed, gave some ground for entertaining this opinion; and the breed of sheep, on which this mixture was most generally applied, is naturally the worst which exists in Britain for the production of wool, the fleeces more nearly resembling coarse hair than wool; but Mr. Bakewell, in his Treatise on Wool, observes, that “in Northumberland, where the fine-wooled sheep have received the benefit of greasing with a mixture in which the proportion of tar was merely sufficient to give it due tenacity, the wool is greatly improved by the process, but the ignorance or selfishness of the wool-buyers for a long time prevented the acknowledgment of the fact.” Many were afraid to purchase the wool on account of its dirty appearance, but its value is now better understood in the Yorkshire markets, and it is purchased by the manufacturers of coloured cloth in preference to the ungreased wool

of the same degree of fineness. The same preference is also given to the cloths in the halls, where they are fold in an undressed state. When these cloths are finished, their superiority is more apparent, possessing a degree of softness far beyond the ungreased wool. These wools appear to improve in every process of the manufacture, and yield a cloth of greater value by twenty or thirty *per cent.* than the ungreased hard wools, though the latter may be equally fine.

But even in Northumberland, where the wool is so greatly improved by the practice, its good effects in this respect are not sufficiently known, and the operation is delayed till the approach of winter. By this delay, the upper part of the staple which is first grown, is deprived of the advantage of being kept in a moist soft state during the summer heat. When the operation has taken place, a perceptible improvement may be observed in the wool which is afterwards grown. The line of distinction is clearly marked by the stain which the unguent leaves in the staple, the bottom part of which, where it is applied, is finer and softer than the upper part which was grown before its application. This difference is so great, that a careful examination of the fine-greased wools of Northumberland might alone be sufficient to demonstrate the advantage of the practice, and the inconvenience of delaying the operation to the end of the year. To derive the most advantage from the ointment both to the wool and the sheep, it should be applied immediately after shearing, and again at the approach of winter. By the first greasing, the wool will be kept soft and moist during the sultry heats of July and August, and the top of the staple would not become harsh and discoloured, which is frequently the case with English wool. One acknowledged advantage of greasing immediately after shearing should not be overlooked; it destroys the sheep-tick, and has a tendency to prevent cutaneous distempers, and to protect the skin from the bite of the fly. The manner of preparing the ointment in Northumberland is as follows:—From sixteen to twenty pounds of butter are placed over a gentle fire, and melted; a gallon of tar is then added, and the mixture stirred with a stick until the tar and butter are well combined, and form a soft tenacious ointment. Some skill is required in its application, the want of which has prevented the practice from prevailing more generally. If the ointment be rubbed on the wool, it collects on the top of the staple, where it detains the loose soil, and becomes hard, and is injurious to the wool. The proper method is to divide the staples or locks with one hand, and apply the ointment with the finger immediately upon the skin; it is thus kept constantly soft by the warmth of the animal, and is equally diffused through the fleece. Attention to this circumstance is of the greatest importance to the success of the practice. The quantity laid on each animal varies in different districts. In the lighter mode of greasing, one gallon of tar and twenty pounds of butter will be sufficient for fifty sheep. In Scotland, where greasing is applied merely to preserve the animal against the inclemency of the climate, a much larger portion of tar is used: this would be very injurious to the wool, were it of any other than the very coarsest kind.

Could a cheap substitute for tar be found, which would possess equal tenacity, the ointment might be applied with great advantage to all our native breeds of English sheep, both for the preservation of the animal and the improvement of the wool. Mr. Bakewell states, that long combing-wools, which have been greased in this manner, produce a softer and superior yarn to any ever made from wool of the native English breeds which have not undergone the process.

cefs. On all chalk and light calcareous foils, the wool is always much harfter than wools of the fame degree of fineness grown on argillaceous or filiceous foils; and this arises from the calcareous earth penetrating the fleece, and absorbing the natural grease, and thus rendering the fibres hard and elastic. These foils cover a large portion of the south-eastern counties of England, and of some of the midland counties; and it is well known to cloth manufacturers that the wool from these districts do not work so well, nor make so soft a cloth, as wool on siliceous or argillaceous foils. Nor will this wool felt in the fulling-mill like the softer wools. The practice of greasing would be of undoubted advantage in calcareous districts, applying the ointment more sparingly than in the northern counties. Perhaps twenty-five pounds of butter, and one of tar, or two of bees'-wax, might be sufficient for one hundred South-Down sheep; and if the mixture were applied once after shearing, and again in October, the expence would be abundantly compensated by the improved condition both of the sheep and wool. The softness of wool appears to be essentially connected with the property of felting, and depends partly on the structure of the surface of the fibre, and partly on its possessing but a moderate degree of elasticity. The process of felting is best illustrated in the hat manufacture, where the fibres of wool or fur are brought into contact by pressure and warmth, and form a compact substance without the aid of spinning and weaving. In some parts of Tartary, coarse cloth for tents is manufactured by spreading the wool on the ground, and pressing it in warm water with the feet; this was probably the first mode of making cloth. All good woollen cloth is still woven comparatively loose, and is made firm and close in the fulling-mill. The fibres of wool or fur have a tendency to move more easily in one direction when pressed, than in the opposite direction. This motion has been compared to that of an ear of barley placed under the coat-sleeve, with the points of the beards downwards; by the action of the arm the ear is moved in a retrograde direction, until it has advanced from the wrist to the shoulder. When we draw a hair of wool or fur through the fingers in a direction from the points to the root, we can feel a sensible degree of roughness, which is not felt if the hair be drawn from the root to the point. Hence we may suppose, that the surface is covered with a number of points or rings, which are too minute to be observed by the microscope, except in some kinds of fur, as in that from the South-sea seal, in which, with a powerful microscope, we have seen the surface covered with distinct leaves or points, shaped like those of the artichoke. We have a striking illustration of this tendency of the fibre to move in one direction in that particular process of hat-making, where it is intended to cover the felt or substance of the hat with fur of a superior kind. The felt on which this fur is to be laid being finished, the hair of the beaver is uniformly spread upon the surface, and being covered with a cloth, it is pressed and agitated by the hand for a certain time. The fibres of beaver-hair introduce themselves by their roots into the felt, and proceed to a certain depth, and become firmly fixed in it. If the pressure were continued for a longer time, the hairs would pass entirely through the felt, going out at the under surface, as each hair follows the direction it acquired at the beginning of the process.

As the felting property, therefore, seems to depend on the minute structure of the surface of the fibre, it is easy to conceive how this may be injured by a dry calcareous soil, and how this property is best preserved in those furs

which are grown under a covering of coarse hair, and protected from external injury. The process of greasing is in some respects a substitute for such a covering, and not only defends the surface, but prevents the fibre from becoming dry, harsh, and elastic. The ancient Greeks and Romans were in the practice of covering their soft-woolled sheep, called *molles oves*, with skins: this has been supposed to have been intended merely as a protection from briars and underwood; but we have no doubt that wool so covered would be much softer than wool exposed to the action of light, and of the soil. That the rays of the summer sun have a tendency to make wool both coarser and harfter, may be seen in the effect produced on sheep that are exposed to it without shelter immediately after shearing. The top point of the staple which was grown at that time is almost always coarser and harder than the bottom of the staple which has been grown under the cover of the upper part of the fleece, and consequently more protected from light. An analogous effect is produced on the skins of horses kept in coal-mines, which become sleek and soft. These facts may suggest to wool-growers desirous of improving their wool, the advantage of providing shade for their flocks during the sultry heats of summer. The natural instincts of sheep might teach them the impropriety, not to speak of the cruelty, of keeping their sheep in summer inclosed in pens, and unsheltered, upon a dry soil, where the animals are almost roasted alive; a practice not less injurious to the health of sheep than to all the best qualities of the wool. Next to a regular supply of food, protection from the effects of heat and wet are objects of the first importance in the management of sheep; and it may be stated as an undoubted truth, that whatever contributes to the comfort of the animal, will enable it to fatten with a smaller quantity of food, will tend to preserve it in a healthy state, and will also increase the quantity and improve the quality of the wool.

Wool, Chemical Examination of. The chemical properties of wool are very similar to those of hair, and as we omitted to speak of these in their proper place, we shall introduce them here.

From the experiments of Achard and Hatchett, it appears that hair contains gelatine, to which it owes its suppleness and toughness. When hair is boiled in water, this principle is separated, and the hair becomes much more brittle than before. Indeed, if the process be continued long enough, the hair crumbles to pieces between the fingers. The portion insoluble in water possesses, according to Mr. Hatchett, the properties of coagulated albumen.

Mr. Hatchett has concluded, from his experiments, that the hair which loses its curl in moist weather, and which is softest and most flexible, is that which yields its gelatine most readily; whereas strong and elastic hair yields it with the greatest difficulty, and in the smallest proportion. This conclusion has been confirmed by a very considerable hair merchant in London, who assured him that the first kind of hair was much more injured by boiling than the second.

Vauquelin has published a curious set of experiments on human hair of different colours. He found it completely soluble in a Papin's digester. During this process, sulphuretted hydrogen was evolved. The solution thus obtained contains a kind of bituminous oil, which is deposited very slowly. This oil was black when the hair was black, but yellowish-red when red hair was the subject of experiment. When this oil was removed, nut-galls and chlorine produced copious precipitates. Silver was blackened, and acetate of lead precipitated brown. When concentrated by evaporation, it did not concrete into a jelly.

WOOL.

Water containing only four *per cent.* of potash dissolves hair, while hydro-sulphuret of ammonia is evolved. If the hair be black, a thick dark-coloured oil, with some sulphur and iron, remain undissolved. If the hair be red, this oil is yellowish. Acids throw down from this solution a precipitate, soluble in excess of acid.

Sulphuric and muriatic acids become red when first poured on hair, and gradually dissolve it. Nitric acid turns hair yellow, and dissolves it, while an oil separates, varying in colour, as before-mentioned, according to the colour of the hair employed. The solution contains a great deal of oxalic acid, besides bitter principle, iron, and sulphuric acid. Chlorine reduces it to a substance of the consistence of turpentine, partly soluble in alcohol.

Alcohol, digested on black hair, extracts from it two kinds of oil. The first, which is white, subsides in white shining scales as the liquor cools; the second is obtained by evaporating the alcohol. It has a greyish-green colour, and at last becomes solid. From red hair alcohol also extracts two oils, one white, as above, the other red as blood. After this latter has been extracted, the hair becomes chestnut. Hence its red colour appears to depend upon this oil.

Hair on incineration yields iron and manganese, sulphate and carbonate of lime, muriate of soda, and a considerable proportion of silica. The ashes of red hair contain less iron and manganese. Those of white hair still less; but in those we find magnesia, which is wanting in the ashes of other hair. The ashes of hair do not exceed .015 of the hair.

Hence, according to this analysis, hair consists of

1. Animal matters constituting the greatest part.
2. A white solid oil, small in quantity.
3. A greyish-green oil, more abundant.
4. Iron, state unknown.
5. Oxyd of manganese.
6. Phosphate of lime.
7. Carbonate of lime, very scanty.
8. Silica.
9. Sulphur.

Vauquelin infers from these experiments, that hair depends for its colour upon a kind of oil, which varies according to the colour of the hair in which it is found. He also supposes, that sulphuret of iron contributes to the colour of black hair. The sudden change of colour in hair from grief, he thinks, is owing to the evolution of an acid. Bichat, however, attributes this change, perhaps with greater probability, to the absorption of the colouring principle. To whatever cause it be owing, the fact appears undoubted; and it shews a closer connection between the living powers and the hair, than many physiologists are inclined to admit.

Wool appears, according to the experiments of Berthollet, to coincide almost exactly in its chemical properties with those of hair above-mentioned. When growing on the back of the animal, it is enveloped in a greasy matter, called the *yolk*, and which appears to be a kind of soap; or, more properly speaking, according to the experiments of Vauquelin, who has examined it, of

1. A soap of potash.
2. Carbonate of potash.
3. A little acetate of potash.
4. Lime.
5. A little muriate of potash.
6. An animal matter.

This substance appears to have the property of protecting the animal from insects to a certain degree, and of preserving

the softness of the wool, which are perhaps its chief uses. It is removed from the wool before it is manufactured, by the process termed *scouring*. The affinity of the animal matter of wool for all colouring principles is very great, and in general far exceeds that of the different vegetable fibres, as cotton, flax, &c. for such principles. There is one kind of coarse wool, however, which, according to Dr. Bancroft, does not possess this property, and receives colours with great difficulty. See *DYEING*, and the preceding article.

WOOL, Laws relating to. The jealousy entertained on the subject of our wools, may be learnt from the legal restriction which has been made in relation thereto; as also with the view that as much employment as is possible may be found for the labouring classes. This is effected by the prohibition of the exportation of wool in an unmanufactured state, as will be seen below. It must be obvious, however, that it would be to little purpose to be thus strict respecting the article itself, if that which produced it was not equally guarded; therefore as early as 13 & 14 Ch. II. c. 18. it was made felony to export sheep from England or Ireland, or even to Scotland: now however the penalty is forfeiture of every ram, sheep, or lamb, and the vessel in which such is shipped with intent to exportation from Great Britain and the islands belonging thereto; and offenders are to forfeit 3*l.* for every sheep, &c. so shipped, and to suffer three months solitary imprisonment, and till the forfeiture be paid, but not to exceed twelve months; and for any second offence 5*l.* for each ram, &c. and six months imprisonment, and till the fine is paid, but not to exceed two years. 28 Geo. III. c. 38. § 2.

By the 9th and 37th sections, no wool, woolfells, mortlings, yarn, or worsted made of wool, woolstocks, coverings, cruels, waddings, or other manufactures, or pretended manufactures slightly wrought up so that it may be reduced to wool again, or mattresses, or beds stuffed with wool combed or fit for combing or carding, may be shipped or exported, or carried or moved for that purpose, from Great Britain, or Guernsey, Jersey, Alderney, Sark, or Man, to any foreign place, on forfeiture of the wool, with the carriage, ship, or cattle on which it is laden or removed; but 300 sheep may be sent annually from Liverpool or Whitehaven to the Isle of Man (51 Geo. III. c. 50.); and the person offending to forfeit 3*s.* for every pound weight, or 50*l.* in the whole, and to be imprisoned three months, and till the penalty is paid, but not to exceed six months; but for a second offence he is to forfeit the like sums, and to be imprisoned for six months, and till such fine be paid, not exceeding two years; but this is not to extend to lambskins dressed for furs and linings.

And persons qualified by the governors of the following islands may export the respective qualities set against them from Southampton to those places in every year:

	Tods.
To Jersey - -	4000
To Guernsey - -	2000
To Alderney - -	400
To Sark - - -	200

28 Geo. III. c. 38. § 16, 17. And 20,000 pounds weight of worsted and woollen yarn may be exported annually from London to Lower Canada, by permission of his majesty in council. 47 Geo. III. c. 9. 52 Geo. III. c. 55.

By the 48 Geo. III. c. 44. wool may be shipped in England for exportation to Ireland, on being duly entered and bond given for its true exportation there; and upon obtaining a licence under the hands of the commissioners of the customs to allow it.

No wool shipped to be sent coastwise from one part of Great Britain to another, until due notice be given and bond entered into, and a licence obtained under the hand of three commissioners of the customs. Penalty, forfeiture. 28 Geo. III. c. 38. § 34. And wool must also be shipped coastwise in British ship, British owned and manned, the owner of which does not reside out of Great Britain. § 19. and 12 Car. II. c. 18. Formerly there were penalties and forfeitures for keeping or removing wool in Kent and Sussex within certain distances of the sea (ten and fifteen miles), without entry and bond, and procuring certificates or permits, and also for removing wool within five miles of the sea-coast of Great Britain before sun-rising and after sun-set; but by the 54 Geo. III. c. 78. all the regulations formerly required *antecedent to the removal of wool on land throughout England* are repealed.

Wool to be packed in packs, or trusses of leather, or canvas, called 'Pack-cloths,' or in linen or woollen, and to be marked 'Wool,' in letters three inches long, on forfeiture of the wool, and 1s. per pound. 28 Geo. III. c. 38. § 28.

Persons packing wool, &c. into boxes, barrels, casks, or chests, and other than as above, or pressing or steaming the same, to forfeit the goods, and 3s. per pound. *Ibid.* § 30, 31.

Infurances for the conveyance of wool contrary to this act void, and the parties may be punished. § 45, 46, 47, 48.

King's ships empowered and required to search ships for wool shipped without licence. § 49, 50, 51.

No person can seize wool unlawfully removing but officers of customs, excise, and salt-duties, or persons accompanied by a constable (§ 52.); and persons neglecting their duty to forfeit 20l., and making collusive seizures or agreements to be subject to like penalties as exporters. (§ 53, 55.) Hindering, obstructing, or beating officers, subjects offenders to transportation; and bribery of them, whether accepted or not, to the penalty of 300l. § 56, 57.

If any question arises upon the growth of the wool, the *onus probandi* is to lie upon the owners. § 60.

Informations may be laid in any court of record, and penalties, &c. under 200l. may be determined before two justices of the peace; and justices at quarter-sessions may direct ships, goods, wool, &c. to be sold. § 62, 63.

Prosecutions to be commenced within three years. § 77.

Wool the growth of Ireland may be exported to England, and no where else. 1 W. & M. c. 32. 7 & 8 W. III. c. 28. 10 & 11 W. III. c. 10. 26 Geo. III. c. 11.

And the Admiralty is to appoint three ships of the sixth rate, and eight or more armed sloops, to prevent the exportation of wool from Ireland to foreign ports. 5 Geo. II. c. 21.

Wool the produce of any of the colonies, &c. in America, or countries on the continent of America, subject to any foreign European states, imported into certain British West India islands, may be imported into Great Britain under the regulations of the 12 Car. II. c. 18.

Those places are, Jamaica, Granada, Dominica, Antigua, Trinidad, Tobago, New Providence, Crooked island, St. Vincent, Bermuda, Caicos, Tortola, Curacoa, and the Bahamas. 27 Geo. III. c. 27. 45 Geo. III. c. 57. 47 Geo. III. sess. 2. c. 34.

British hare or coney wool may not be exported, (except to Ireland, 39 & 40 Geo. III. c. 67.) on penalty of forfeiture. The owner or shipper to pay 100l., and the master of the ship 40l. 24 Geo. III. c. 21.

Wool, *Cheese made under*, in *Rural Economy*, a term

applied to that sort of high-tasted ewe cheese which is made before the sheep are shorn. See CHEESE.

Wool, *Pack of*, a quantity of wool packed up closely together in a large bag of the sack-cloth kind, which in London is constituted of two hundred and forty pounds. See WOOL.

Wool, *Pocket of*. See POCKET.

Wool, *Sarplar of*. See SARPLAR.

Wool-*Stapler*, a person who staples and deals in wool. See WOOL.

Wool-*Stapling*. See STAPLING of Wool.

Wool-Balls, in *Natural History*, masses of wool compacted into firm and hard balls, and found in the stomachs of sheep, as the hair-balls are in oxen and other animals.

These are doubtless formed in the same manner as those hair-balls of the outer covering of the animal; but they are much more uncommon; they are found in numbers, three, four, or five, in the stomach of the same animal. Their outside has commonly much the same appearance of a puff-ball, and is usually either in part or wholly covered with a very thin and soft blackish smooth skin; the inner substance is entirely wool, but that wrought together as closely as the latter does his furs in the making of them into hats.

They are usually soft, smooth, and somewhat elastic, of a pale buff-colour, very light, and of irregular figures rather cubic than globular, and seldom of any great size, an inch in diameter being their common standard. Moreton's Northampt. p. 451. See BALLS.

WOOLASSEY, in *Geography*, a town of Bengal; 42 miles N.E. of Calcutta.

WOOLDALE, a township of England, in the West Riding of Yorkshire, near Wakefield.

WOOLDAW, a town of Bengal; 40 miles W. of Nagore.

WOOLDERS, *Single and Double-Handed*, in *Ship-Building*, are sticks about three feet long, and four inches in circumference, with straps of rope-yarn made fast, to fix on the rope in making, and assist the men at the hooks in closing the rope.

WOOLDING, is winding several close turns of rope in a tight manner round the masts and yards, that are made of several united pieces, to strengthen and confine the same together. In making new masts and yards, this method is discontinued, and iron hoops used in lieu.

Woolding is also the rope employed in this service.

WOOL-DRIVERS, are those who buy wool of the sheep-owners in the country, and carry it on horseback to the clothiers, or market-towns, to sell it again.

WOOLER, anciently WILLOVE, in *Geography*, a market-town, and parish in the ward of Coquet-dale, and county of Northumberland, England. The former is situated near the Cheviot-hills, 17 miles S. from Berwick-upon-Tweed, 46 N. by W. from Newcastle, and 320 in the same direction from London. In 1811 the houses in the parish were 284, inhabited by 1704 persons. A market is held on Thursday, and fairs on the 4th of May and 17th of October. Wooler was a barony, and consisted of several manors in the time of Henry I., who conferred it on Robert de Muscamp, whose successor Robert, in the reign of Henry III., was the most powerful baron in the north of England: it now belongs to the earl of Tankerville. The church was rebuilt in 1765, and the town contains some meeting-houses for dissenters. Situated near the confines between the kingdoms

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doms of England and Scotland, the environs of Wooler present many intrenchments, cairns, and other memorials of the sanguinary conflicts which in former times occurred between the rival nations on the borders. About ten miles N. from the town, on the road to Scotland, is the celebrated Flodden-field, where the Scotch, in 1513, received a signal defeat, and James IV. was slain.—*Beauties of England, Northumberland*, by the Rev. J. Hodgson, 8vo. 1812.

WOOLHASA, a town of Algiers; 6 miles N.W. of Tackumbreet.

WOOLLEN MANUFACTURE, *Progress of the*. The origin of the woollen manufacture, like that of many other useful arts, is not precisely known. At a very early period, domestic sheep were extensively spread over Western Asia. The introduction of sheep into Europe is not recorded by ancient writers, unless we suppose the expedition of the Argonauts to Colchis refers to this event. Sheep were probably first domesticated for their milk, and afterwards for their skins, which must have been the first dress of pastoral nations. Sheep and goats, in the early ages of society, were nearly of equal value. The Greeks, who ostentatiously refer all useful discoveries to their own country, and rank their inventors among the gods, have ascribed to Minerva the invention of spinning and weaving. These arts appear, however, to have been first practised, at a very early period, in Egypt, and applied to the spinning and weaving of flax. At what time they were first applied to wool is unknown. Though Pliny informs us, that Nicias of Megara discovered the art of fulling cloth, the property which wool possessed of felting was known in the East at a much earlier period, and probably gave rise to the first manufacture of woollen goods which were not woven, but felted like the substance of hats.

On this subject, Mr. Luccock, in his *Treatise on Wool*, judiciously remarks, " whilst the skins of sheep dressed with their wool on served as clothing, it is obvious that only one useful fleece could be obtained from one animal, and as the fleece is generally cast, or falls off once a year, this produce must have been wasted. In a very early period, however, the property which wool possesses of felting was discovered, or, in other words, it was found that by pressure and moisture the fibres of wool might be made to adhere together, and produce a compact pliable substance, quite as durable and more convenient than the skins formerly used. This appears to have been the first effort to produce a woollen manufacture." It is probable the felting property was discovered by accident, as some fleeces will felt upon the sheep's backs; among farmers, these are called cotted fleeces. When the application of this discovery was first made, the knowledge of the art was soon widely spread. The tents of the Arabs and Tartars are, at the present day, all made of felt from the wool of sheep, mingled with the hair of goats, camels, and other quadrupeds, and may be considered as remains of the original art of cloth-making.

The art of spinning and weaving threads made from wool was, in all probability, derived from the East; they are alluded to by Moses as existing nearly fifteen hundred years before the Christian era, and it appears that the early patriarchs had numerous flocks of sheep.

The greater part of these sheep, we are informed, were, at first, either dark-coloured or spotted; hence we may infer that the art of dyeing wool was then unknown. When the selection and cultivation of white wool gave to woollen cloth the property of receiving the tints of the dyer, the value and use of wool must have greatly increased, owing to the great estimation in which richly-coloured garments are held by people advancing to a state of civilization.

Thus, in addition to the superior pliability and comfort of woollen cloth, compared with skins or felts, the taste for it must have been widely spread by the art of dyeing. It had also the great recommendation to its general adoption, that it could be fabricated with ease in every family. The machinery required for the purpose was extremely simple. The distaff and the loom, says Mr. Luccock, were little more in the hands of the first manufacturers, than the spade in those of the husbandman. Spinning and weaving, as we have already observed, were in use at least fifteen hundred years before the Christian era; but the manner in which they were performed is not related until about three centuries afterwards. Then the loom consisted of a frame of wood, in some respect different from the modern one, but well adapted to the same purposes.

The alterations which have been made in it consist, perhaps, more in the position of the beam, and the mode of opening the web for the passage of the shuttle, than in any other circumstance. Nor was the earliest mode of spinning less perfect, than that which was practised in the most celebrated manufacturing countries for many ages afterwards. It was performed by means of a rod or staff, about which the wool to be spun was carefully wrapt, and held in the left-hand, while a rough kind of spindle, quickly twirled betwixt the right-hand and the thigh, was suffered to continue its motion when suspended by the thread which the artist gradually lengthened with his fingers. This least complex of spinning-machines is not entirely laid aside even now. A few years since it was not uncommon in the county of Norfolk, and its continuance in use through so many ages is the best proof of its excellence.

The preparing of wool for spinning was probably first effected by the fingers, and afterwards by the fuller's teazle or thistle, the *diplacus fullorum*, which with its rough and hooked points was well adapted to the purpose, and has continued in use to the present day. The card afterwards used was probably a substitute for the *carduus*, or teazle. The application of the wheel to a spindle, or the spinning-wheel, is, we believe, unnoticed in history. Whenever these inventions took place, it is probable their first introduction contributed more to increase the quantity, than improve the quality of the yarn and cloth. For a considerable period after the commencement of the woollen manufacture, the improvements made in spinning or weaving of wool were effected by the improved address and skill of the manufacturer, rather than by any alteration in his machinery, as we now see the manufacturing nations of the East execute very elaborate works with instruments of the most simple construction. In proportion as luxury and refinement increased, the demand for superior fabrics would induce the growers of wool to pay great attention to the fleece, and to select and preserve for breeding those sheep which produced the softest and finest wool; with the ancients these terms were synonymous. The produce of fine white wool from sheep is entirely the result of cultivation; it has never been grown except in countries where the woollen manufactures have flourished. The race of fine-woolled sheep has, however, been partly preserved in those countries after the destruction of their trade. The grower would also soon learn to pay particular attention to the whiteness of his fleeces, as a clear white ground is necessary for receiving the most brilliant dyes. Blue, purple, and scarlet, were the tints most admired; and though the ingredients, by means of which they were produced, are in some measure unknown, yet we have the most indubitable testimonies to their excellency, and the estimation in which they were held. To produce them in their richest
lustre,

lustre, a selection of the wool most adapted to receive them must be made, and this would operate with great precision upon the wool-sorter's attention.

While the manufacture of wool was confined to the houses of the grower, and the business of it transacted by his domestics in a secluded state, there was less room for the stimulation and exercise of invention than in after-ages, when it became the appropriate calling of one particular part of the community, and their success depended upon the opinion which others formed of the fabric. Yet in the simplest days of Greece, it was not deemed an employment unsuitable to palaces, nor did a princess degrade her dignity by superintending the labours of the loom, the distaff, and the dyeing vat.

We have little information respecting the woollen manufactures of the Greeks and Romans, as distinct from their domestic manufactures; but large establishments were necessary for the clothing of distant armies, and for foreign commerce. That the Romans had carried the manufacture of fine woollen cloth to a high degree of perfection, is proved by a variety of circumstances, and particularly by the great attention paid to the cultivation of fine-woolled sheep, and by the high prices at which the wool and sheep were sold, as appears from the writings of Pliny, Varro, and Columella. Pliny describes two kinds of sheep: the one which grew coarse long wool, and was on this account called *hirtum* or *hirsutum*, and from its hardness and ruder treatment *colonicum* or rustic; the other breed was called *molle*, from the softness of the wool, and *generosum* or noble, from its excellence; also *pellitum*, from its being clothed with skins to protect the wool. The race is sometimes also called Tarentinum, Apulum, Calabrum Atticum, and Græcum, from the neighbourhood or district in which it chiefly lived; but what is of more importance, as shewing the origin of the fine-woolled sheep of Italy, the race is called Asianum; and, according to Pliny, a similar race existed in his time at Laodicea in Syria. The description given of these sheep by Pliny agrees with the present race of Merino sheep. There is not, says Dr. Parry, throughout Europe, any breed of short-woolled sheep now existing besides the Merino, of which the males are horned and the females not.

That the Romans imported their Tarentine sheep into their western colonies, with the art of manufacturing fine cloth, we learn from Strabo and Pliny. The former writer, who flourished in the reign of Augustus, says, that in Turdetania in Portugal, then a part of Spain, "they formerly imported many garments, but now their wool was better than that of the Coraxi, and so beautiful, that a ram for the purpose of breeding was sold for a talent, and that fabrics of extraordinary thinness were made of this wool by the Saltræ." Probably this was similar to the shawl cloth of India, and woven in the same manner, as Pliny calls it *scutulatus*, a term which he applies also to the spider's-web. The little attic talent of silver is estimated to equal in value 216*l.* of English money, which shews the high estimation in which the best wool was held even in the colonies of Rome.

All ranks of people of both sexes among the Romans chiefly wore woollen garments. In the reign of Aurelian, 270 years after Christ, a pound of silk, according to Vopiscus, was equal to a pound of gold. A people so pre-eminent in wealth, and in all the refinements of art, would naturally be solicitous to attain the highest degree of excellence in the manufacture of those fabrics, which were calculated to gratify their passion for adorning their persons, and it was equally as necessary to consult their ease as

their vanity. The summer-heat of Italy was so great, that the affluent could scarcely have supported a woollen dress, had it not been made of the lightest and thinnest cloth. We find also, that during the Augustan age, and for a considerable time afterwards, it was the fashion to wear cloths which, as at present, were furnished with a raised nap or pile. Such cloths were called *pexæ*, in contradistinction to *tritæ* or thread-bare. Thus Horace:

"—— Si forte subucula pexæ
Trita sub est tunicæ —— rides."

"You laugh if you espy a thread-bare vest
Under a well-dressed tunic."

And also Martial:

"Pexatus pulchre, rides mea, Zoile trita."

The term *pexatus*, applied to cloth, leads us to suppose that the nap or pile was raised with a comb, having very fine teeth. Pliny informs us, that in his time the price of wool had never exceeded 100 sesterii the libra, or pound; now the Roman sesterius being about 8*d.* of our money, and the libra about 5245 grains, it follows that an avoirdupois pound, or 7008 grains, would have cost about 1*l.* 2*s.* of our money. From the intercourse with Persia and the East, the Romans would become acquainted with the shawl-cloths of India, and would naturally wish to imitate so beautiful and delicate a fabric. These are made from very soft fine short wool, and not from combed wool, as has been generally supposed in this country. The existence of that manufacture in Hindoostan for many ages, is a proof of the high degree of perfection to which the fabrication of woollen cloth had been carried in former times. For shawl-cloth is only woollen cloth, woven with a twill, and unmilled, but it is spun to a great degree of fineness, and from wool so peculiarly soft, that it has never been rivalled by any European nations. The perfection of the colours, and the skill displayed in the weaving, we have no reason to believe are greater now than in the time of Alexander the Great; and if these manufactures were successfully imitated by the Greeks or Romans, or even distantly approached in the manufacture of their fine cloths, we may form some idea of the perfection to which they had arrived. When in the decline of the Roman empire, their colonies were overrun by savage barbarians, all their public establishments and manufactures were destroyed, but the art of producing from the fleece a warm and substantial clothing was never entirely lost, even during the darkest days of ignorance. It began to revive, and became the separate occupation of one class of the community about the middle of the tenth century in the Low Countries, where it remained the glory of the people, and the source of their opulence, through more than four hundred years. The wool which it consumed for the first few years was the produce of their own pastures, which had but lately been reclaimed from the forest; but as the manufacture extended itself, the demands became larger, and were supplied from a greater distance. The wealth which it distributed was soon visible, and people crowded into the country, engaged in its commerce, and pushed their speculations with increasing vigour through a hundred and fifty years, when an inundation of the sea threatened to involve the art, the artist, and the country, in one general destruction. The dispersion of the people who fled from the calamity which appeared to overwhelm their hopes, instead of destroying the infant manufacture, gave it additional vigour, and was the means of establishing a connection between

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tween the Netherlands and foreign countries, which proved of the highest importance to commerce. It contributed to a much more speedy recovery of the arts connected with the woollen manufacture, from the ruin which seemed to threaten them, and gave a striking instance of their partiality for the seats where they have once flourished, under the patronage of a government liberal enough to encourage, and sufficiently powerful to protect them, even in situations attended with natural disadvantages. The influence of these manufactures upon the fleeces of the Low Countries must have been very considerable; for before the year 960 we have no reason to suppose that their quality was superior to that which we find in the neighbouring districts; yet it was not very long ere Flanders and Brabant became famous for the manufacture of fine cloths, even at a period when they imported but little foreign wool. Perhaps the fabrics might not be equal to those which we now produce from the fleeces of Spain, or even from the improved ones of our own sheep, but they were preferable to those of England and the nations of the continent, Italy and Spain excepted. It was about the year 1200 that the merchants began to import the wools of other countries, to extend their connections much more widely, and to grow by this means still more rich and powerful. The manufactures required a larger quantity of the raw material than usual, and the population of the country had reached that extent which does not admit of a great number of sheep being kept, even though the employment of the people depend upon the fleeces, and their subsistence upon the food which they furnish. We shall observe instances of a similar kind when we treat more particularly of England. The operation of these two causes was evidently sufficient to induce the manufacturer to go farther from home, and to seek the most convenient methods of supplying his looms. It might have been expected that he would have turned his attention to France and to Germany; but independent of the hostile dispositions of some of the neighbouring sovereigns, the raw material was too bulky to be conveyed at an easy expence through the bad roads of a half cultivated country; and the ships of Spain and of Britain, who found an interest in supplying the wants of the Netherlands, unladed their cargoes almost at his very door, and solicited in payment but little else than the goods which he had manufactured.

Spain was the first country on the western side of Europe, where the Tarentine breed of fine-woolled sheep were cultivated with success by the Romans. See SHEEP.

This breed, intermixed with the native flocks, gave rise to the present fine-woolled sheep of Spain; and it does not appear that this valuable race was ever greatly neglected in that country. That it abounded in sheep in what is called the middle age cannot be doubted. At the period when the Saracens extended themselves in Spain, about the eighth century, to use the quaint words of Roderic, archbishop of Toledo, "it was fruitful in corn, pleasant in fruits, delicious in fishes, favourable in milk, clamorous in hunting, and gluttonous in herds and flocks,"—*gulosæ armentis et regibus*. He wrote in A.D. 1243. In England at that time sheep were so scarce, that a fleece was estimated at two-thirds the value of the ewe which produced it, together with the lamb.

Into Spain the invaders either carried the arts of luxury, or, what is more probable, improved them by their superior industry. The revenue of one of their sovereigns in the tenth century amounted to six millions sterling; a sum, says Gibbon, which at that time probably surpassed the united revenues of the Christian monarchs. When, several centuries afterwards, the Saracens were gradually expelled by their

Christian neighbours, Spain saw nothing but the change of religion to compensate the loss of population, of agricultural and mechanical science, of industry, and wealth. On the recovery of the Seville from the Moors in 1248, not less than 16,000 looms are said to have been found in that city. Of these, the greater number was probably employed in the fabric of woollen cloths. According to Uftarix, "Theory and Practice of Commerce," the manufactures of Segovia flourished most, both in point of number and quality, and were in high esteem, being the best and finest that were known in ancient times. The temperature of the climate, and the luxurious propensities of the inhabitants, would naturally determine these fabrics to be of the lightest and softest kinds. Hence in the midst of the boasted ancient manufactures of England, we read only of two or three instances of the importation of English cloth into Spain. The Spaniards had certainly at that time their own native fleeces best adapted to their own taste and climate.

We are told by Dillon, in his "History of Peter the Cruel," that the woollen cloths of Barcelona were in high esteem in Seville in the reign of that prince, and in the preceding century. So far back as 1243, the woollen cloth of Lerida is spoken of in terms of great estimation. A few years after, Baurlas, Valis, Gerena, Perpignan, and Tortosa, were remarkable as manufacturing towns, and for the fineness of their cloths, fustians, and serges. So great was their exportation, that in 1353 there were 935 bales of cloth taken on board a ship from Barcelona to Alexandria by a Genoese privateer; and 1000 bales of cloth were taken on board three Catalonian ships in 1412, by Antonio Dorco, in the port of Callus. We are told by the same author, that, according to records still extant in Barcelona, considerable orders for wool were sent to England in 1446, in order to be manufactured there and returned to England in the form of cloth, the Spaniards themselves disdaining to wear it.

According to Lucius Marineus Siculus, who wrote in the time of the emperor Charles V., Spain was then full of herds and flocks, more especially it contained innumerable sheep; so that many shepherds, whom he knew, had flocks of 30,000 each; on which account Spain not only supplied its own people most abundantly, but also foreign nations, with the very softest wool.

This account is confirmed by what is related by Sandoval, who states, that in an insurrection in Spain in 1519, the army of insurgents, among whom were many cloth-workers, stipulated, among other points, that the cloths imported into Spain should be of the same size and goodness as those wrought there; and that the merchants and clothiers might have leave to seize, in order to work up, half the wools sold for exportation, paying the owners the price at which they had been bought. Hence we learn the superiority of Spanish cloth, and the great sale of Spanish wool to foreign countries at that time.

Damianus a Goes, who was page to Emanuel, king of Portugal, in 1516, has written a short account of the memorable things of Spain, which he dates at Louvain in the year 1541. In this work he says, that there are annually exported from Spain to Bruges 40,000 sacks of wool, each selling at the lowest for twenty gold ducats.

Now from an authentic acquittance, preserved in the Fœdera, from queen Elizabeth to Cosmo de Medici, for a sum borrowed by him of Henry VIII., we find that the gold ducat or florin was in 1545 equal to five shillings of our money. In this year, the 36th of Henry VIII., the base coinages began; but as queen Elizabeth seems to have continued receiving the instalments of the Florentine debt

for several years at the same rate, when the shilling was of something more than the present value, we think it probable that the rate was fixed at the beginning of the year 1545, when the shilling was at 1s. 1 $\frac{3}{4}$ d. of our present coin. This wool was, therefore, worth at least 5*l.* 14*s.* 7*d.* the sack of 181 $\frac{1}{2}$ lbs., and 11*l.* 9*s.* 2*d.* the sack of 364 lbs.

In 1560, in the time of Guicciardini, Spanish wool in the Netherlands was at a somewhat lower price. He tells us, "that they used formerly to send annually from Spain to Bruges more than 40,000 sacks, but that in this year the Spaniards, having made more cloth at home, had sent only 25,000 sacks, at 25 crowns each." The crown being 4*s.* and the shilling 1*s.* 0 $\frac{1}{4}$ d. of our money, this would be 10*l.* 1*s.* 1*d.* the sack of 364 pounds. The depreciation seems in truth to have arisen from a diminished demand for this wool in the Netherlands. The wools imported into the Netherlands from Spain were the lower or coarser kinds.

The superfine wools of Spain seem to have been first introduced among the Italian states. Thus Damianus a Goes in 1541, after having specified the 40,000 sacks to Bruges, as before-mentioned, adds, "and also to Italy, and other cities of the Netherlands, are annually sent about 20,000 sacks, of which those used in Italy, being of the choicest wool, are sold at from forty to fifty gold ducats each."

From this account, we have a fair opportunity of drawing two important inferences: the first is, that the Spanish wool which went to the Netherlands was, as we have before observed, of the coarsest kind, being of only half the price of that which was exported to Italy; secondly, we can compare the value of the latter with that of our English wool, the best of which, according to the act of parliament in 1534, already quoted, did not in England exceed 5*s.* the stone of 14 pounds, of 6*l.* 10*s.* the sack of 364 pounds. The shilling, however, being then equal to 1*s.* 4 $\frac{1}{2}$ d. of our coin, increases the price of the sack 8*l.* 18*s.* 9*d.*; to which add custom and subsidy, 3*l.* 13*s.* 4*d.* or 5*l.* 0*s.* 10*d.*, and the result will be 13*l.* 19*s.* 7*d.* The additional charges of freight and merchant's profit would scarcely bring the whole amount to 16*l.* 16*s.* On the other hand, according to the testimony of Damianus a Goes, the Spanish sack of 181 $\frac{1}{2}$ pounds was in 1541 worth 14*l.* 6*s.* 5 $\frac{1}{2}$ d., and the sack of 364 pounds 28*l.* 14*s.* 6*d.* of our present money. If the author speaks only of the value of this wool in Spain itself, then a farther addition must be made of freight, merchant's profit, and probable duty to the crown. On the whole, this calculation is sufficient to shew in the strongest light the superior price of superfine Spanish wool, to that of the very best at that time produced in Britain.

Next in order of time to the Italians, the manufacture of superfine wool seems to have been adopted by the French, who, according to Guicciardini, in 1560 sent by land to Antwerp some very fine cloths of Paris and Rouen, which were highly prized.

It is probable, however, that these cloths were made only of mixed wool.

A strong confirmation of the early use of the best Spanish wool, unmixed with coarser by the Italian states, is furnished by Richelieu's Political Testament, printed in 1635, in which, speaking of the fine woollen manufactures of France, the author says, "the Turks prefer the draps de sceau de Rouen to all others, next to those of Venice, which are made of Spanish wool."

And the author of "England's Safety in Trade's Increase," written in 1641, tells us, that "the greatest part of their (the Venetians) wools from Spain, and the rest from Constantinople, is commonly brought in English shipping."

In 1646, Nicholas Cadeau and other Frenchmen had letters patent for twenty years, for making at Sedan black and coloured cloths, like those of Holland, of the finest Spanish wool.

The inhabitants of the north of Europe, as before-mentioned, were not at first able to manufacture fine Spanish wool, without the assistance of that which was longer and coarser. But what in the beginning was a matter of necessity, became afterwards an object of choice; and the more skilful clothiers, whether in Holland or elsewhere, either carding the finer and dearer Spanish with the coarser and cheaper English, or forming a warp of the latter, which they covered with a woof of the former, contrived to make a cheap and serviceable cloth, which pleased the eye equally well with the more costly fabrics of entire Spanish wool. This though generally concealed with great care at the time, yet is afterwards candidly acknowledged by writers actually engaged in the commerce of wool, and sufficiently refutes the prejudices which had here prevailed from the middle of the 16th to the middle of the 17th century. Hence it appears that our wool, when placed in connection with Spanish, was chiefly valuable from being well calculated not to improve but to adulterate it.

A treaty between France and Spain in 1659, enabled the former freely to obtain the wool of the latter, and thus to gain great advantage over us in the Levant trade. From the proximity of France to the woollen manufactures in the north of Spain, it might have been expected that the French would have earlier engaged in this manufacture; but owing to their frequent northern wars, and their attention being directed to the manufacture of silk, the French do not appear to have commenced the fabrication of woollens for exportation extensively before the 16th century. About this time, France made great progress in her manufactures of wool, and in securing the export trade, particularly that to Tartary, for which she was better situated than Holland or England.

The nature of her trade to warm climates directed her attention to the fabrication of finer and lighter cloths, than those made by her northern neighbours; in consequence of which she preserved the greater part of the Turkey trade to the period of the French revolution, and in general fine French cloths had attained a celebrity for their superiority, both in texture and dye, over those of any other country in Europe. The native breeds of sheep in France were greatly improved by intermixture with sheep imported from Spain. With these advantages, France might have nearly secured a monopoly of the finer branches of the woollen manufacture, had not the absurd policy of her rulers, in the revocation of the edict of Nantz, driven the manufacturing Protestants to other countries, where they contributed, by their exertion, their skill, connections, and capital, to form establishments which rivalled those of the country from which they were expelled.

Notwithstanding this, as France supplied the greater part of her own population of twenty millions with cloth, besides her foreign exports, we conceive that the woollens manufactured in that country, before the late revolution, equalled in quantity the cloth made in England at the time, and greatly exceeded it in value. Under the emperor Napoleon, the best Merino stocks were imported in multitudes from Spain, which have spread over the country, and are equal to supply extensively her manufactures of woollens, when they shall be again fully established. Considerable quantities of fine wool have been imported from France into England since the peace of 1815.

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The confusion attendant on a great revolution, continued for twenty years, gave so severe a blow to the manufacturing establishments of France, that a considerable time must elapse before they are completely established. Prior to this revolution, the superfine cloths of France were superior to those of England, in texture, colours, and softness. In the finer articles of worsted goods, and in the mixed worsted goods made partly with long combing-wool, and partly with silk or goat's-wool from the Levant, they surpassed the manufactures of this country; but the manufacturers of the commoner kinds of worsted goods, as tammies and shalloons, could not rival us in foreign markets for want of a proper supply of wool suited to the purpose. The following were the principal seats of the superfine and fine woollen manufactures in France, arranged according to the different qualities of the goods made at each, beginning with the finest:

1. The manufactures of Gobelins.
2. Of Sedan.
3. Of Abbeville.
4. Of Louviers.
5. Of Elbœuf.
6. Of Rouen and Darnetal.

Besides several detached manufacturing establishments of superfine cloth in Languedoc, Champagne, and other parts of France.

At the Gobelins, superfine cloths of the very first quality were manufactured; but the manufactures there were confined solely to the broadest white cloth intended to be dyed scarlet or purple, and the brightest colours from cochineal.

Sedan followed next to Gobelins for the beauty of its superfine cloths, where they were also made of various breadths and colours.

Abbeville may be placed next after Sedan: some have even supposed that it equalled Sedan in the fineness of its cloths; but this arose from the cloths of the latter place being of various sorts: the lower kinds were certainly inferior to those of Abbeville; but the quality of the greater part of the cloths of Sedan were of a better kind than the average quality of the cloths of Abbeville. In the manufactures of Sedan, each manufacturer confined himself to a particular kind of cloth, for which he became distinguished, some being celebrated for fine, and others for superfine cloths exclusively; whereas in Abbeville, Louviers, and the other districts enumerated, there were manufacturers who made various sorts, and the proportion of the fine to the superfine was greater than at Sedan.

Elbœuf was one of the most ancient seats of the woollen manufacture in France, but the quality of the cloths made there had greatly degenerated from the years 1760 to 1770; but afterwards the manufacturers returned to the former quality of their cloths, which were partly made of the fine wools from Bessy, and partly from fine Spanish wool, or from a mixture of Spanish with the best wools of Berry.

Rouen and Darnetal may be placed in the sixth class of manufacturing districts of fine cloth, in which the finest wools of France were principally used, mixed with those of Spain.

The establishments for the manufacture of common cloth and coarse woollens were much more widely spread over France. The goods appear to have been principally consumed in that country to supply the demand of a population of twenty millions, and the numerous military establishments, besides what might be sent to the French colonies.

As the French never exported any considerable quantity of common or coarse woollen cloths, the manufactures of these articles never equalled in extent those of England. The circumstance of the coarse cloth manufacture being so widely spread over the country, tended also to prevent that degree of rivalry which promotes the spirit of improvement where manufactures are more concentrated; add to this, the French had not that abundant supply of the coarser clothing-wools which could enable them to rival us in the export of heavy woollen goods.

The worsted manufactures of France, including ferges and those goods made with a warp of worsted, were principally carried on in four of the provinces of France, but more extensively in Picardy than elsewhere. The long combing-wools which supplied this manufacture, were partly the produce of France, and partly imported from Holland, England, Flanders, and Germany. M. Rolland, in the French Encyclopædia, describing the French manufactures in the year 1783, soon after the American war, says, that during that war the English administration tacitly encouraged the exportation of wool to promote the interests of agriculture. He describes the French combing-wool as being coarser and more harsh than the wool of Holland, as wasting much more in the manufacture, and making goods of a very inferior quality. The combing-wools of England, though generally less found and fine, and of a less pure white, than those of Holland, were particularly well suited to some parts of the worsted manufacture.

The combing-wools from Germany were coarse and harsh, and only used in default of other supplies. Very fine worsted yarn was also obtained from Saxony and the environs of Gottingen; but this yarn was tender, and required to be mixed with worsted yarn from English or Dutch wool. The yarn of Turcoign was supposed to be Dutch, but was principally from Flanders and Artois. The goat's-wool came from the Levant, by way of Marseilles, in bales of from 200 to 300 lbs. It sold from four livres to twelve livres *per* French pound; and the price of that most generally used was about 4 livres 10 sous *per* pound. The silks used in silk camelots, &c. were obtained from Paris and Lyons.

The following table gives the quantity and value of wool yarns and worsted pieces in Picardy; but he supposes the quantity to be under the real amount, the manufacturers concealing the extent of their trade to avoid arbitrary taxation.

Wool consumed in the Worsted Manufactures of Picardy.

	fous.	livres.
French wool	3200000 at 22	3520000
Dutch ditto	180000 at 40	360000
English ditto	200000 at 32	320000
German ditto	100000 at 22	110000
	3680000	4310000

Yarn imported.

	liv. s.	
Yarn of Turcoign	60000 at 8 10	510000
German yarn	100000 at 7 0	700000
Levant yarn, or mohair	220000 at 5 10	1210000
Silk used in fine worsted goods	20000 at 35 0	700000

Total value of wool and yarn - - - 7430000
4 M 2 Brought

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Brought forward	7430000
Combing and spinning 3680000 lbs. of wool	4310000
Winding, warping, and weaving	4770000
Dyeing of yarn and pieces	1900000
Profit of the wool-dealers, manufacturers	1300000
<hr/>	
Total value of 150000 pieces coming from the manufacturer	18000000
Value of dyeing-wares	5000000
To which carriage and profit of the merchant and draper	2000000
<hr/>	
Total value of worsted goods in Picardy	20500000

One million and fifty thousand pounds weight of wool were also consumed in hosiery in the same province, of which the greatest part was native; and the remainder about two hundred and fifty thousand pounds weight from Holland. The number of working manufacturers in Picardy is thus stated:

50000 men who gain 140 livres <i>per annum</i>	7000000
50000 women	3500000
150000 children	6000000

The greater part of the manufacturers resided in the country, and were employed part of the time in agriculture; this was also the case with the manufacturers in the towns, so that not more than eight months in the year were devoted to manufactures. This change of employment, so conducive to the health and comfort of the labouring classes, may be regarded as presenting the happiest form under which manufactures can be carried on. This was also in a considerable degree the situation of the woollen and worsted manufacturers in Yorkshire, before the late introduction of machinery had driven the population into large factories; a change which may be regarded as one of the greatest evils that ever afflicted civilized society, tending directly to degrade and enfeeble the human race, and to render man a wretched machine, a prisoner from the cradle to the workhouse or the grave, devoid of moral feeling and physical energy.

What was the extent of the worsted manufacture in the other provinces of France where it was carried on, we have no correct means of ascertaining. In the middle of the last century, the export of cloths and worsted goods from Languedoc alone amounted annually to about 60,000 pieces, sent to the Levant and to Barbary. At that time also, Spain, and all the countries bordering the Mediterranean, received worsted goods from France. In the variety of worsted articles, in the ingenuity of the patterns, and the superiority of the workmanship, as well as of the dyes, France may be regarded as having surpassed any other nation in Europe, prior to the year 1780, or about the close of the American revolution. Since that period, the manufactures of England have astonishingly increased, and have obtained a decided preference in foreign markets.

The woollen manufactures of Saxony and Germany have been long established; the fugitives from the edict of Nantz contributed much to improve and extend them. During the late war, all the manufactures in Germany and every part of the European continent suffered greatly, but are at present rapidly reviving, and will abridge the amount of our exports in Europe.

In Russia, Sweden, and Denmark, the woollen manufacture, as a distinct occupation, is comparatively new; yet it has existed long enough to produce great alteration

in their flocks. And as this change was attempted in a more enlightened period, and conducted by scientific men, the best means were adapted to promote the improvement, and new breeds of sheep have been introduced into both countries. The same remark applies to Saxony and other circles of the German states, and even Hungarian flocks are not without evident indication of a change for the better.

Of the worsted manufacture as distinct from the woollen, we have little information respecting its origin. It comprises all those goods made of combed wool in distinction from carded wool. We are unacquainted with the period when the wool-comb was invented, or when worsted goods were first manufactured. It is probable, that worsted goods were originally woven in the East, and that the knowledge of them was brought into Europe either by the Armenian merchants, or those who returned from the extravagant expeditions which were undertaken for the recovery of the Holy Land from the dominion of the infidels. The garments which are now worn by the Turks, some of which seem to have been produced by means of the comb, the incidental mention of that instrument in an account which we have of Angora, and the demand for worsted goods through the Levant, confirm the conjecture, and lead us to suppose, that there exist very considerable manufactures of this kind in the Turkish empire, although we know little more of its domestic and rural condition, than can be obtained from the most vague accounts and uncertain deductions. After the art of spinning worsted yarn was known in the west of Europe, the looms of the Netherlands became active in converting it into those peculiar kinds of goods to which it was adapted, and it seems as though the distinction between these and woollen articles was not generally noticed until some years afterwards. It might have been expected from the nature of the article, that the manufacture of worsted goods should in many southern countries have preceded that of cloth. Long-stapled wool suited to the comb seems more spontaneously the produce of uncultivated sheep, than short wool, which is to be manufactured by carding, and its mode of manufacture more nearly resembles that of flax; hence it is not improbable, that worsted goods were made in Egypt and the East before the manufacture of woollen cloth. This is, however, uncertain.

In the manufacture of long wool, the fibres are arranged parallel to each other, like those of flax; but before they are spun, they require to be laid even by some kind of instrument, which shall separate the fibres, that they may draw out easily in spinning. A comb of a very simple construction, with a few wires for the teeth, was probably first made use of. It was afterwards found, that the application of heat to the comb contributed more effectually to the regular arrangement of the fibres; and thus the invention of the common wool-comb arose, but at what period is unknown. Vulgar tradition ascribes the invention to bishop Blaize, who first used it in Alderney; but there does not appear any authority in support of this opinion. The bishop lived in Armenia, and was raised to the episcopal dignity about the time of Dioclesian, and suffered martyrdom under that tyrant. Before he was beheaded, he was tortured with iron combs, with which his flesh was torn; and hence when an instrument of that kind was brought into common use, the workmen chose him for their patron saint. The traditions of the origin and progress of the worsted manufacture are thus extremely imperfect; we shall have occasion to speak of its introduction and progress in this country in the following section.

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Rise and Progress of the Woollen Manufactures in England.

—The Romans, as we have stated on the authority of Camden, had a cloth manufacture at Winchester. The first account of any distinct body of manufacturers afterwards occurs in the reign of Henry I., but either the people of this country were wholly clothed in skins or leather in the intervening space, or, what is more probable, coarse cloths were manufactured in a rude manner in most of the towns and villages in England. A great part, however, of the dress of the labouring classes in the country was made of leather, particularly the breeches and waistcoats, even till the present reign. George Fox, the founder of the Quakers, in the reign of Charles I., travelled on his missions through the country, buttoned up in a leathern doublet, or waistcoat with sleeves, which supplied the place of a coat. This was not, as his adversaries afterwards affirmed, from any superstitious prejudice respecting that costume; it was the common dress of the labouring mechanics at that time, to which class he belonged.

The first account of any foreign weavers settled in England is recorded by William of Malmesbury and Giraldus Cambrensis, who relate that a number of Flemings were driven out of their own country, by an extraordinary encroachment of the sea in the time of William the Conqueror. They were well received, and first placed in the neighbourhood of Carlisle, and on the northern frontier; but not agreeing with the inhabitants, they were transplanted by Henry I. into Pembroke-shire. They are said to have been skilful in the woollen manufacture, and are supposed to have first introduced it into England as a separate trade. Cloth-weavers are mentioned in the exchequer accounts as existing in various parts of England in the reign of Henry I., particularly at London and Oxford. The weavers of Lincoln and Huntingdon are represented as paying fines for their guild in the 5th of Stephen; and in the reign of Henry II. (1189), there were weavers in Oxford, York, Nottingham, Huntingdon, Lincoln, and Winchester, who all paid fines to the king for the privilege of carrying on their trade. (*Chronicon Pretiosum*, p. 64.) There were also cloth dealers in various parts of Yorkshire, Norwich, Huntingdon, Gloucester, Northampton, Nottingham, and Newcastle-upon-Tyne; also several towns in Lincolnshire, and at St. Alban's, Baldock, Berkhamstead, and Chesterfield, who paid fines to the king that they might freely buy and sell dyed cloths. These are supposed to have been cloths imported from the Flemings. The red, scarlet, and green cloths, enumerated among the articles in the wardrobe of Henry II., were most probably foreign, as the English had attained little skill at that time in the art of dyeing. Madox's History of the Exchequer.

In the 31st of Henry II. the weavers of London received a confirmation of their guild, with all the privileges they enjoyed in the reign of Henry I.; and in the patent he directed, that if any weaver mixed Spanish wool with English in making cloth, the chief magistrate should seize and burn it. (*Stowe's Survey of London*.) This absurd edict was issued under the pretext of the inferiority of the Spanish wool, but was doubtless intended to encourage the growth of English wool, an article from which our kings derived a considerable revenue. The circumstance rather proves the superior excellence of Spanish wool at that time, and the jealousy which its importation had excited among the English wool-growers.

In the reign of Henry III. an act was passed limiting the breadth of broad-cloths, ruffs, &c. to two yards within the lists. In the year 1284, foreign merchants were first permitted to rent houses in London, and buy and sell their

own commodities, without any interruption from the citizens. Previous to this date they hired lodgings, and their landlords were the brokers, who sold all their goods, and received a commission upon them. It was soon after pretended that the foreign merchants used false weights, and a clamour being raised against them, twenty of them were arrested and sent to the Tower. Amidst the numerous absurd restrictions to which commerce and manufactures were subjected, we need not be surprised at the little progress which they made.

The materials which history affords respecting the woollen manufacture before the reign of Edward III. are but scanty; it appears that the office of aulnager, or cloth inspector, was very ancient. In the reign of Edward I. we are informed by Madox, that Peroult le Tayleur, who held the office of aulnager of cloth in the several fairs of the realm, having forfeited it, the king, by writ of privy seal, commanded the treasurer to let Pieres de Edmonton have it, if he were fit for it, and a writ was made out accordingly, and he took the oaths of that office before the treasurer and barons. The facts above-stated prove the existence of the cloth manufacture in England before the time of Edward III., who is generally supposed to have first introduced the art into the kingdom. There is no doubt, that a new impulse was given to it during this reign by the liberal protection granted to foreign manufactures here: in all probability, they first introduced the manufacture of stuffs from combed wool or worsteds; an art requiring more skill, and more complicated processes, than are employed in the making of cloth.

In the year 1331, John Kemp, a master manufacturer from Flanders, received a protection to establish himself here with a number of dyers and fullers to carry on his trade, and in the following year several manufacturers came over from Brabant and Zealand. It is said, that the king's marriage with the daughter of the earl of Hainault enabled him to fend over emissaries without suspicion, to invite the manufacturers to this kingdom. These manufacturers were distributed over the country, at the following places:—The manufacturers of fustians (woollens) were established at Norwich, of baize at Sudbury in Suffolk, of sayes and ferges at Colchester in Essex, of broad-cloths in Kent, of kerseys in Devonshire, of cloth in Worcestershire and Gloucestershire, of Welsh friezes in Wales, of cloth at Kendal in Westmoreland, of coarse cloths, afterwards called Halifax cloths, in Yorkshire, of cloth in Hampshire, Berkshire, and Suffex, and of ferges at Taunton in Devonshire. (*Rymer's Fœdera*, vol. i. p. 195.) Fresh supplies of foreigners contributed to advance the woollen trade of these districts.

Kendal, in Westmoreland, claims the honour of first receiving John Kemp, where his descendants still remain, and the woollen trade is at present carried on. In the following reign, we find the manufacturers of Kendal petitioning to be relieved from the regulations imposed on broad-cloths. Kendal green is mentioned by Shakspeare as an article of dress in the time of Henry IV., and there is reason to believe, that in the reign of Elizabeth, the woollen manufactures of that town were as extensive as at present.

In the year 1336, two woollen manufacturers from Brabant settled at York, under the king's protection: they are styled in the letters of protection, "Willielmus de Brabant & Hanckcinus de Brabant, Textores." These persons probably laid the foundation of the woollen and worsted manufactures, which have since so extensively flourished in the western part of that county. It is not very improbable, that the manufacturer Hancks, called Hanckcinus,

gave

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gave the name to the skein of worsted, which is to this day called a hank.

The references which we have soon afterwards to the woollen manufacture, as existing in the districts before-named, tend to confirm the belief, that the distribution of the foreign manufacturers we have given is correct. About this time, we learn that Thomas Blanket, and other inhabitants of Bristol, set up looms in their own houses, but were so harassed by the impositions of the mayor and bailiffs of the place, that they were obliged to obtain letters from the king to permit the free use of their trade, without impediment, calumny, or exaction. The letter to the mayor and bailiffs accuses them in the following terms: "vos diversas pecunie summas ab eisdem Thomas et aliis exigitis et ea occasione multipliciter inquietatis et gravatis, ut asserunt." Dr. Parry has conjectured, that blanket, which at first meant a coarse white undressed cloth, derived its name from the same Thomas Blanket of Bristol. The encouragement given to the woollen manufacturers during this reign, and the consequent consumption of wool at home, diminished the export of it so much, that a duty was laid on cloth exported to supply the place. Blackwell-hall was appointed by the mayor and common council of London for the market, where cloth manufacturers might send their goods for sale, in the year 1357.

In the course of the reign we find several other acts relating to the measurement and fulling of cloth, and the fees to be paid to the aulnager.

In order to form a more distinct idea of the relative value of wool, cloth, and other articles, after and before the reign, it may be proper to refer to the state of the silver coinage.

	Grains.
The 28 Edward I. one shilling contained	264
18 Edward III. - - - - -	236
27 Edward III. - - - - -	213
9 Henry V. - - - - -	176
1 Henry VI. - - - - -	142
4 Henry VI. - - - - -	176
49 Henry VI. - - - - -	142
1 Henry VIII. - - - - -	118
34 Henry VIII. - - - - -	100
36 Henry VIII. - - - - -	60
37 Henry VIII. - - - - -	40
3 Edward VI. - - - - -	40
5 Edward VI. - - - - -	20
6 Edward VI. - - - - -	88
2 Elizabeth - - - - -	89
43 Elizabeth - - - - -	86

at which it continued to the present reign.

The following account of the exports and imports in the 28th of Edward III., said to be found in a record of the exchequer, was published by Edward Misseldon, merchant, in the year 1623.

<i>Exports.</i>	£	s.	d.
Thirty-one thousand six hundred and fifty-one sacks and a half of wool, at six pounds value each sack, amount to	189,909	0	0
Three thousand thirty-six hundred and sixty-five felts at 40s. value, each hundred at six score, amount to	6,073	1	8
Whereof the custom amounts to	81,624	1	1
Fourteen last, seventeen dicker, and five hides of leather, after six pounds value the last, amount to	89	5	0
Whereof the custom amounts to	6	17	6
Carried forward	277,702	5	3

	£	s.	d.
Brought forward	277,702	5	3
Four thousand seven hundred and seventy-four cloths and a half, after 40s. value the cloth, is	9,549	0	0
Eight thousand and sixty-one pieces and a half of worsted, after 16s. 8d. value the piece, is	6,717	18	4
Whereof the custom amounts to	215	13	7
Summary of the out-carried commodities in value and custom	294,184	17	2

Imports.

One thousand eight hundred and thirty-two cloths, after six pounds value the cloth	10,922	0	0
Whereof the custom amounts to	91	12	0
Three hundred and ninety-seven quintals and three quarters of wax, after the value of 40s. the hundred or quintal	795	10	0
Whereof the custom is	19	17	0
One thousand eight hundred and twenty-nine tons and a half of wine, after 40s. per ton	3,659	0	0
Whereof the custom is	182	0	0
Linen cloth, mercury, and grocery-wares, and all other manner of merchandize	23,014	16	0
Whereof the custom is	285	18	3
Summary of the in-brought commodities, in value and custom, is	38,970	13	3
Summary of the impulfage of the out-carried above the in-brought commodities, amounteth to	255,214	3	11

Admitting the correctness of this statement, which we have no reason to doubt, we must observe, that the cloth imported was of a higher value *per* yard than the cloth exported. Hence it may be inferred, that for several years after the arrival of the Flemish weavers, we were partly dependent on foreigners for our fine cloths; the coarser kinds then, as at the present day, forming the larger quantity of our exports. It is obvious also, that worsted goods had become an article of manufacture, nearly equal in importance with the woollen; and hence it is not improbable, that the greater part of the Flemish manufacturers were makers of stuffs and worsted goods, which was probably an entirely new trade in England.

The statutes in the following reigns, relating to the woollen manufacture, prove the narrow and selfish policy by which the manufacturers were influenced: these statutes refer either to restrictions which they wanted to impose, in order to confine the trade to themselves, or are made to prevent them from fraudulently packing or weaving their goods. In consequence of these fraudulent practices, the 13th statute of Richard II. makes the following regulations, which are curious, as marking the spirit of the manufacturers, and also as proving the early establishment of the woollen trade in the western counties, where it now flourishes. It runs thus: "Forasmuch as divers plain cloths, wrought in the counties of Somerset, Dorset, Bristol, and Gloucester, be tacked and folded together for sale; of which cloths a greater part be broken, bruised, and not agreeing in the colour, neither according to the breadth, nor in no manner to the part of the same cloths shewed outwards, but falsely wrought with divers wools, to the great loss and damage

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damage of the people, inasmuch that the merchants that buy the same, and carry them out of the realm to sell to strangers, be many times in danger to be slain, and sometimes imprisoned and put to fine and ransom. Therefore it is ordained, that no plain cloth tacked and folded shall be set to sale within the same counties." The same act permits certain cloths of coarse wool to be made of the breadth of three quarters, and appoints one weight and measure through the kingdom, except in the county of Lancaster. Another statute, in the same reign, allows every person to make cloth of what length and breadth he will, provided the aulnage and other duties are paid, and it be measured and sealed by the king's aulnager, and contain no deceit. The kinds of worsted goods which might or might not be exported, were also specified in this statute. During this reign it appears, notwithstanding the increase of our trade, that we annually exported about one hundred and thirty thousand packs of wool, paying a duty of one hundred and sixty thousand pounds.

In the 4th of Henry IV. the cloths made in London and the suburbs were ordered to have a seal of lead attached, and in a subsequent statute no cloths were to be folded before the aulnager had set his seal to them. In the following reign, the narrow cloths, called the dozens of Devonshire and Cornwall, are ordered to pay cocket customs, after the rate of broad-cloths.

In the reign of Henry VI. the exportation of woollen yarn is prohibited, and this prohibition seems to have been in full force when wool was allowed to be freely exported. The only reason assigned for this is, that the yarn paid no duty. During this reign two cloth-searchers were appointed for every hundred throughout the realm, who were to inspect and seal all cloth, taking one penny for each. This proves that the manufacture of woollens had spread over a great part of the kingdom. It is probable that this inspection extended to all cloths made in private families, which were sent to the fulling-mills.

The worsted trade was also increasing rapidly at this time: four wardens of worsted-weavers were appointed for the city of Norwich and two for the county of Norfolk, who were to make due search of worsteds, and of what length and breadth they were made. In the same reign it was ordained, that "if our woollens were not received in Brabant, Holland, and Zealand, then the merchandize growing or wrought within the dominions of the duke of Burgoine shall be prohibited in England, under pain of forfeiture." Hence we learn, that we very soon began to supply these same countries with woollens and worsteds, from which we had received workmen a century before.

In the third year of Edward IV. the woollen trade had increased so much, that the importation of woollen cloth, caps, &c. was prohibited. Woollen caps or bonnets were then universally worn; they were either knitted or made of cloth, and a large quantity of wool must have been consumed in their fabrication. About the year 1482, hats made from felts were introduced; but the manufacturers of caps, called the cappers, continued a powerful body a century afterwards. In the same reign, the wardens of worsteds at Norwich were doubled, or increased to eight.

The manufacture of fine broad-cloth must have been considerably improved about this time; for in the fourth of Henry VII. it was thought prudent to fix a maximum on the price of fine cloth, by which every retailer of cloth who should sell a yard of the finest scarlet grained cloth above sixteen shillings, or a yard of any other coloured cloth above eleven shillings, was to forfeit forty shillings *per* yard for the same.

In the year 1493, in consequence of a quarrel between Henry VII. and the archduke Philip, all intercourse between the English and Flemish ceased, and the mart for English goods was transferred from Antwerp to Calais. This interruption to the regular course of trade was severely felt by the woollen manufacturers. Lord Bacon, mentioning the renewal of the trade with Flanders, which took place again in 1496, says, "By this time the interruption of trade between the English and Flemish began to pinch the merchants of both nations very sore. The king, who loved wealth, though very sensible of this, kept his dignity so far as first to be fought unto. Wherein the merchant adventurers likewise did hold out bravely; taking off the commodities of the kingdom, though they lay dead upon their hands for want of vent." The merchant adventurers he describes as "being a strong company, and underfet with rich men." It is not, however, very probable, that this company would continue to purchase goods without a prospect of gain. These merchant adventurers were divided into two bodies; those of London, which were the most powerful; and the merchant adventurers of England, who paid a fine to the former on all goods sold at the foreign marts.

In the reign of Henry VIII. the woollen trade, and particularly all kinds of worsted manufactures, appear to have been in a very flourishing state, though trade suffered several severe checks from the wars in which we were engaged. In the year 1527, Henry having entered into a league with France against the emperor Charles V., all trade with Spain and the Low Countries ceased. The goods sent to Blackwell-hall found no purchasers, the merchants having their warehouses filled with cloths; the poor manufacturers being thus deprived of employment, an insurrection took place in the county of Suffolk, where four thousand of them assembled, but were appeased by the duke of Norfolk. The merchants were summoned to appear before cardinal Wolsey, who in the name of the king reprimanded them in an angry tone for not purchasing the goods brought to market, and threatened them that his majesty would open a new mart at Whitehall, and buy of the clothiers to sell again to foreign merchants; to which menace one of them pertinently replied, "My lord, the king may buy them as well at Blackwell-hall, if it pleases him, and the strangers will gladder receive them there than at Westminster."—"You shall not order that matter," said the cardinal; "and I shall send into London to know what cloths you have on your hands, and by that done, the king and his council shall appoint who shall buy the cloths, I warrant you." With this answer the Londoners departed. Grafton's Chronicle, vol. ii. p. 1167-8.

The interference of the cardinal raised the spirits of the manufacturers for a time, but originating in ignorance of the nature of trade, it could only have a temporary effect, and goods fell again till a truce between England and Flanders was made for the benefit of trade. This fact shews the dependance of England, even at that time, on the export of manufactured woollens. In this reign we find Lancashire and Cheshire first named as seats of the manufacture of coarse woollens; they are mentioned, together with Cornwall and Wales, as districts where friezes were made. It appears from various references, that Norfolk and Suffolk were then flourishing seats of the worsted manufacture, and of all goods made with a worsted warp. Wardens were allowed to the towns of Yarmouth and Lynn, but with a selfish restriction, that the pieces were to be dyed, spun, or callendered in the city of Norwich. In the last year of this reign, an act was passed to prevent any persons

persons besides woollen manufacturers, who bought wool for their own use, and merchants of the staple, who bought for exportation, to purchase wool with the intent to sell again. This act extended to twenty-eight counties, and secured a monopoly of the wool to the merchants of the staple, and to the rich clothiers. In the first year of the following reign, Edward VI., it was repealed, so far as to allow every person dwelling in Norwich and Norfolk, to buy wool the growth of that county, by themselves or agents, and retail it out in open market. The reason assigned is this: That almost the whole number of poor inhabitants of the county of Norfolk and city of Norwich had been used to get their living by spinning of Norfolk wool, which they used to purchase by eight pennyworth or twelve pennyworth at a time, selling the same again in yarn; and because the grower chose not to parcel it in such small quantities, therefore for the benefit of the poor, the wool of Norfolk was allowed to be purchased by wool-dealers. By this act, the 33d of Henry VIII., for prohibiting the exportation of yarn is made perpetual. The manufacture of woollens in the counties adjoining London appear to have been extensive, particularly in the county of Berkshire; for in the beginning of the reign of Henry VIII., John Winchcombe, of that county, commonly called Jack of Newbury, was celebrated as the greatest clothier in England. He kept one hundred looms in his own house, and in the expedition against the Scotch, he sent to Flodden-field one hundred men, fully equipped, at his own expence. Even so early as the 13th century, one Thomas Cole was distinguished by the name of the rich clothier of Reading, in Berkshire.

York, then the second city in the kingdom, and from its connection with the port of Hull well situated for the export trade, was probably an early seat of the woollen manufacture. We have already mentioned the settlement of two clothiers from Brabant in the time of Edward III. We do not learn precisely in our early historians, when the manufactures emanated from that city into the western parts of the county; but from an act in the 34th of Henry VIII. we are informed, that the chief manufacture of that city was the making of coverlets; the act recites, "that the poor of that city were daily employed in spinning, carding, dyeing, weaving, &c. for the making of coverlets, and that the same have not been made elsewhere in the said county till of late; that this manufacture had spread itself into other parts of the county, and was thereby debased and discredited, and therefore it is enacted, that none shall make coverlets in Yorkshire but the people of York." Thus we see, under the flimsy pretext of public benefit, the manufacturers were willing to disguise that selfish spirit of monopoly, which disgraces almost every page of our commercial history. The municipal regulations of the city of York, which were, and still continue to be, hostile to a free trade, probably obliged many manufacturers, who were not sharers in the monopolies of the guild, to establish themselves in the western villages of the county, where provisions were cheaper, and where they could carry on their trade without restriction. In the reign of Philip and Mary, soon after this period, we have the following interesting account of Halifax, in consequence of an act passed in the 37th of Henry VIII. to prevent any other persons than merchants of the staple and woollen manufacturers from buying wool in the county of Kent and twenty-seven shires. The poorer manufacturers, who were unable to lay in their stock of wool at one time, being hereby deprived of their trade, made application for redress, which was granted. The act recites as follows: "Whereas the town of Halifax being

planted in the great waste and moors, where the fertility of the ground is not apt to bring forth any corn nor good grafs, but in rare places, and by exceeding and great industry of the inhabitants; and the same inhabitants altogether do live by cloth-making, and the greater part of them neither getteth corn, nor is able to keep a horse to carry wools, nor yet to buy much wool at once, but hath ever used to repair to the town of Halifax, and there to buy some two or three stone, according to their ability, and to carry the same to their houses, three, four, or five miles off, upon their heads and backs, and so to make and convert the same either into yarn or cloth, and to sell the same, and so to buy more wool of the wool-driver; by means of which industry, the barren grounds in those parts be now much inhabited, and above five hundred households there newly increased within these forty years past, which now are like to be undone and driven to beggary by reason of the late statute (37th of Henry VIII.) that taketh away the wool-driver, so that they cannot now have their wool by such small portions as they were wont to have, and that also they are not able to keep any horses whereupon to ride or fetch their wools further from them in other places, unless some remedy may be provided. It was therefore enacted, that it should be lawful, to any person or persons inhabiting within the parish of Halifax, to buy any wool or wools at such time, as the clothiers may buy the same, otherwise than by engrossing and forestalling, so that the persons buying the same do carry the said wools to the town of Halifax, and there to sell the same to such poor folks of that and other parishes adjoining, as shall work the same in cloth of yarn, to their knowledge, and not to the rich and wealthy clothier, or any other to sell again. Offending against this act to forfeit double the value of the wool so sold."

From this we learn that many woollen manufacturers had been either driven from York at an early period, by the oppression of the municipal regulations, or had retired where provisions were cheaper, and where they had better streams for the erection of fulling-mills, and for other processes of the manufacture, such as dyeing and scouring.

The woollen manufactures also gradually retired from the vicinity of the metropolis, owing to the increased price of provisions and labour, and probably also to the difficulty of obtaining commodious streams for the scouring and fulling of cloth, when the country round London became more populous. In the latter part of the reign of Henry VIII. we are informed, that the king demised to William Webbe the subsidy and aulnage of all cloth made in the county of Monmouth, and in the twelve shires of Wales. A former act of this reign, speaking of the manufacturers of North Wales says, they had been used to sell their cloths so craftly and hard rolled together, that the buyer could not perceive the untrue making thereof. These acts prove the extension of the woollen manufactures westward.

In the same reign, an act mentions the woollen manufactures as being established in Worcestershire, but prohibits any one from making cloth in the county, except within the city of Worcester, and in the towns of Evesham, Droitwich, Kidderminster, and Bromsgrove; and forbids the owners of houses in those places from letting them at advanced prices to the cloth-manufacturers. The woollen manufacture has continued to the present day at the two last of these towns. In the reign of Edward VI. Coventry and Manchester are mentioned as manufacturing places. The manufacturers in the old established seats of the woollen trade appear to have been greatly alarmed at the extension of the cloth manufacture, and to have exerted all their influence to restrain it. Near the conclusion of the reign of Philip

Philip and Mary, an act in 53 sections was passed, relating to the making of woollen cloths. It enacts, that no person shall make woollen cloth but only in a market-town, where cloth hath commonly been used to be made for the space of ten years last past, or in a city, borough, or town corporate. From this restricting act, however, the following exceptions are made: to all persons who dwell in North Wales or South Wales, Cheshire, Lancashire, Westmoreland, Cumberland, Northumberland, the bishopric of Durham, Cornwall, Suffolk, Kent, the town of Godalmin in Surrey, or in Yorkshire, being not within twelve miles of the city of York, or any towns or villages near the river Stroud in Gloucestershire. This act, so absurd and oppressive, was obliged to be modified in the first year of the following reign, by an act entitled "An Act for the continuing and making of Woollen Cloths in divers Towns in the County of Essex." Bocking, Watherfold, Cockshill, and Dodham, are the towns specified.

In consequence of the increase of our manufactures, the export of wool had nearly ceased before the reign of Elizabeth; and a considerable advance appears to have taken place in the price of food, clothing, and rents. The export trade of England was carried on very extensively by three companies of merchants, the merchants of the Stillyard, who were foreigners, the merchants of the Staple, and the merchant adventurers, who were English. See **STILLYARD, STAPLE, and ADVENTURERS.**

The merchants of the Stillyard were of ancient standing, and were originally from the Hanse towns: they had great privileges granted them, and particularly they were allowed to export and import all wares and merchandize, on payment of the small duty of one and a quarter *per cent.* This gave them a decided advantage over the other companies; and it is alleged that they lent their name to cover the import and export of goods belonging to private merchants, and thereby evaded the regular duties on such goods. This company had engrossed a considerable part of the cloth trade. In the year 1551 they exported 44,000 cloths; soon after which this company was dissolved. The merchant adventurers succeeded to that branch of their trade: according to the account of John Wheeler, secretary to the company, there were annually shipped by them 50,000 white cloths, worth 600,000*l.*, and 40,000 cloths of all sorts, baizes and kerseys, worth 400,000*l.*, besides wool and woolfels. We are told by Camden, that, in his reign, the commerce between England and the Netherlands rose to above twelve millions yearly, and the woollen trade alone amounted to five millions. The Latin terms which Camden employs, *milliones aureorum*, leaves the amount intended uncertain: if we suppose it to be ducats, the quantity is much greater than England exported at that time; probably florins were intended, which makes the amount about 750,000*l.*

Besides the exports to Antwerp, English cloth was at this time sent to Amsterdamb, Hamburgh, Sweden, Russia, and other countries. The woollen trade of England had now advanced to a higher state of prosperity than at any former period; and from this time it appears to have declined until after the revolution of 1668. In this reign, the price of wool, which we believe to mean long or combing wool, had advanced from 13*s.* 4*d.* to 22*s.* *per* tod; and the shilling containing the same weight of silver as our late coinage, *viz.* 86 grains, the relative value of a tod of long wool was considerably more than it has ever been during the present reign.

The declension of our manufactures in the succeeding reigns of the Stuarts, as we have reason to believe, extended much more to woollen cloths than to worsted pieces. Long

wool, or combing-wool, was more the peculiar produce of England than clothing-wools. The latter were grown in abundance, and of a superior quality, in Spain, Portugal, and France; but the combing-wools of England, on account of the superior foundness of the staple or fibre, and the quantity supplied, gave a decided advantage to our manufacturers of stuffs or worsted pieces.

The persecution of the Protestants by the duke of Alva in the Netherlands drove multitudes of the manufacturers into England, where they were graciously received by Elizabeth, who gave them liberty to settle at Norwich, Colchester, Sandwich, Maidstone, and Southampton. These refugees contributed to extend our manufactures of worsted goods and light woollens, called bays and says; they also introduced the manufacture of linens and silks, and it is supposed that they first taught the art of weaving on the stocking-frame.

In the latter part of the reign of Elizabeth an act was passed to relieve the counties of Somerset, Gloucester, and Wiltshire, from those absurd and oppressive statutes which confined the making of cloth to corporate towns. This act, which gave to all persons residing in these counties the privileges of free trade, could not fail to extend and establish the woollen manufactures in these parts, and they have remained to the present time the principal seats of the superfine cloth trade, whilst many manufacturing corporate towns, which were then flourishing, have sunk to decay. Various acts, regulating the length, breadth, and tentering of woollen goods of different kinds, were also passed in this reign, referring to the counties of Oxfordshire, Devon, and the counties north of Trent, particularly Yorkshire and Lancashire. The importation of foreign wool-cards was also prohibited. The act recites, that many thousands of woollen card-makers and card-wire drawers, living in London, Bristol, Gloucester, Norwich, Coventry, and elsewhere, had heretofore subsisted themselves and families upon that business, which was now greatly impaired by the importation of wool-cards. No laws prohibiting the export of wool were thought necessary in this period of our history, and it continued to be exported during the whole of this reign, as appears by the account of the merchant adventurers, who exported it together with cloth; but though wool was freely exported, an act was passed to prevent the carrying of live sheep, lambs, or rams out of England; but the reasons for this act are not recited, though it states it was for divers good causes and considerations. The internal tranquillity that the country enjoyed during this long reign, the influx of foreign makers of new kinds of worsteds, and other articles not known before, the opening of a new trade to Turkey and the Barbary states, by treaty in the year 1579 and in 1585, all greatly contributed to the extension of the woollen trade and manufactures. There were indeed other circumstances which must have operated against our manufacturers in part of this reign. The interruption of commerce between England and the Netherlands in 1564, which lasted some time, the wars with Spain, the sacking of Antwerp, in which the English merchants suffered severely, gave a considerable check to the foreign trade; yet we have seen that the merchant adventurers alone exported woollens to the amount of one million sterling towards the latter end of this reign. The demand at home for woollens must also have greatly increased during the long period of domestic tranquillity which the nation at that time enjoyed, and particularly from the prevailing taste for costly dresses which has spread from the court through the country.

A great part of our woollen exports hitherto consisted of white undressed cloth; but in the following reign of James I. it was represented as bad policy to permit the exportation of cloth in this state, and thereby lose the profit on the

dyeing and finishing. A letter exists addressed to king James on this subject, ascribed to sir Walter Raleigh, but without sufficient evidence, as "the most ancient manuscripts of this letter in the libraries of the nobility ascribe it to John Keymer." (Oldy's Life of Sir W. Raleigh.) In this letter it is stated, "that there have been eighty thousand undressed and undyed cloths exported yearly, by which the kingdom has been deprived of four hundred thousand pounds for the last fifty-five years, which is nearly twenty millions that would have been gained by the labour of the workmen in that time, with the merchants' gains for bringing in dyeing-wares, and return of cloths dressed and dyed, with other benefits to the realm." The writer proceeds, in another part, to state, that there had also been exported in that time annually, of baizes and northern and Devonshire kerfies, in the white, fifty thousand cloths, counting three kerfies to a cloth, whereby had been lost about five millions to the nation in labour, profit, &c. The author informs us, that the baizes so exported were dressed and dyed at Amsterdam, and shipped to Spain, Portugal, and other kingdoms, under the name of Flemish baize, setting their own seal upon them; "so that we lose the very name of our home-bred commodities, and other countries get the reputation and profit thereof." The author concludes with asserting, that the nation loses a million a year by the export of white cloths, which might be dressed and dyed as well at home. This letter has been often quoted as containing unanswerable reasons for confining the whole process of the cloth manufacture to our own country; but, like other monopolists, the writer seems to forget that there are two parties in all mercantile transactions, and that manufactured goods must be sent in that state in which the purchaser is willing to receive them, unless it be proved that he cannot procure them elsewhere. Let us mark the result. Alderman Cockayne, and other London merchants, had sufficient influence with the government to obtain the prohibition of the export of white cloths, and to secure a patent for dressing and dyeing of cloths. In consequence of which, the Dutch and Germans immediately prohibited the importation of dyed cloths from England, which gave so great a check to our export trade, that in the year 1616, the whole amount of cloths exported of every kind amounted only to sixty thousand, so that the export trade in woollens had fallen to less than one-third of its former amount; and in the year 1622,

	l.	s.	d.
All our exports of every kind } amounted only to - }	2,320,436	12	10
Whilst our imports were -	2,619,315	0	0
Leaving a balance against us of	298,878	7	2

It being from experience proved, that the policy of dressing and dyeing all our goods at home had produced the greatest injury to the woollen trade, the restrictions were taken off, and the export for white cloth left free. In the former reign, cloths about four pounds value were, by statute, to be sent out dyed, by all persons except the company of merchant adventurers, who obtained a licence to export all sorts of white cloths; and though this was itself a monopoly, yet, as it gave foreigners an opportunity of receiving our finer cloths in the state which they most wanted, it was the means of increasing our trade: indeed it is said by Misselden, that "within a few years after granting this licence, the vent for cloth in foreign parts increased to twice as much as it had been during the strict observance of the statute." With this fact before their eyes, it is scarcely possible that our statesmen at that time could have proceeded to the pro-

hibition of white cloth exports, unless they had been (as was asserted) influenced by presents from alderman Cockayne and the rich merchants, who expected to receive the benefit arising from the prohibition, and the exclusive right of dyeing and dressing. The wool-growers equally felt the ill effects of this prohibition. Wool is said to have fallen from thirty-three shillings *per* tod to twenty shillings; if by this is meant the long combing-wools, the former price, considering the value of money at that time, is much higher than it has been in the last or the present century.

During the reigns of the Stuarts, the infamous policy they adopted struck not only at the liberty, but at the commercial prosperity of the country. Archbishop Laud, imbued with the malignant zeal of a bigot, commenced his attacks on the descendants of the French Protestants, established as manufacturers of woollens in Norfolk and Suffolk, from which counties his persecuting fury drove some thousand families. Many of them settled in New England; but others went into Holland, where they were encouraged by the Dutch, who allowed them an exemption from taxes and rents for seven years. In return for this, the states were amply repaid by the introduction of manufacturers, with which they were before unacquainted. In the year 1622, king James issued a proclamation to prohibit the exportation of wool, fuller's-earth, &c. In 1640 wool was again admitted to be exported on the payment of certain duties; and we are told, that in the same year sir John Brownlowe, of Belton in Lincolnshire, sold three years' wool at twenty-four shillings *per* tod to a baize-maker of Colchester. As it is reasonable to suppose that this was the long combing-wool of that county, it shews the high relative price of the article at that time. In 1647, owing to the high price of wool, its exportation was again prohibited.

During the civil wars, the manufactures and export trade of England declined, and the Dutch availed themselves of this to extend their own manufacture and export of woollens, particularly to Spain, from whence they brought fine Spanish wool. At this time it appears, that the woollen manufactures in Poland and Silesia were rapidly increasing; and the English government received information that two hundred and twenty thousand cloths were made there annually, besides considerable quantities made at Dantzic, and in the vicinity.

The duke of Brandenburg, it was also stated to our government, had ordered one hundred thousand ells of Silesia cloth at Königsberg for his troops, which had been heretofore supplied with English cloth. The estimation in which our cloth had been held is said to have been lost by negligence in the manufacture, particularly in the spinning and weaving. The Dutch and Poles had a little before this time received a great number of Protestant manufacturers, who fled from the persecution of the duke of Alva in Brabant and Flanders.

Here it may be proper to remark, that the English as a nation had little intercourse with other parts of the world, except through a few large trading companies: hence they were extremely ignorant respecting the state of foreign countries, and supposed that the cloth trade had been confined to their own country for three hundred years; and they considered the establishment of other manufacturers as a novelty and infringement of their just rights. With these views, it was proposed to obtain a complete monopoly of all the clothing-wool in Spain, in order to prevent the Dutch and other nations from rivalling our manufactures. This is the more extraordinary, as the English had not then learned, like the Dutch, to manufacture Spanish wool, without mixing it with that of their own country. It is needless to say, tha

WOOLLEN MANUFACTURE.

the negociation of fir William Godolphin for this selfish monopoly of wool was not successful. During the whole reign of Elizabeth, when our woollen manufactures were in the highest state of prosperity, wool and woofels were permitted to be exported. In the reign of James I. and Charles I., when the trade was declining, proclamations were issued to prevent the exportation of wool, and also that of fuller's-earth. During the commonwealth, an ordinance of parliament was issued to prohibit the exportation of wool and fuller's-earth, on pain of forfeiture of the wool, and a penalty of 3*s.* per pound on every pound of fuller's-earth. The first act of parliament which absolutely prohibited the exportation of wool by making it felony, and which could not be set aside by a royal licence, is the 12th of Charles II., which was passed soon after the Restoration.

The grounds of this measure are stated in the preamble of the act: "For the better preventing the losses and inconveniences which have happened by and through the secret and subtle exportation of wool out of the kingdom; and for the better setting to work the poor people and inhabitants of the kingdom, to the intent that the full and best use and benefit of the principal native commodities of the kingdom may redound to and be unto and amongst the subjects and inhabitants of the kingdom, and not unto any foreign states." Previous to this time, the proclamations and ordinances issued to prevent the exportation of wool, for the most part, signified nothing more than the imposition of a duty or a composition for exporting by licence from the government, what on other terms was forbidden, under penalties of confiscation, fine, or imprisonment. We have seen that, from the death of Elizabeth to the Revolution in 1688, the woollen trade was generally in a languishing state. In the year 1665, Thomas Telham of Warwickshire, with two thousand manufacturers, left the kingdom, and established themselves in the Palatinate, and commenced a woollen manufacture there, and were greatly encouraged by the elector. The establishment was soon afterwards joined by a number of manufacturers from Hertfordshire.

During the period from Elizabeth to the year 1668, the English appear to have made no improvement whatever in their modes of manufacture of woollen cloth, whilst the neighbouring nations had been making a gradual progression, both in the style of their manufacture, and the amount annually produced. It was especially in the manufacture of fine cloths that their superiority was manifest. The Dutch, in particular, were far more expert than the English in the dressing and dyeing of cloth. This will appear from the following remarkable fact stated by Coke, vol. ii. p. 169. In the year 1668, one Brewer, with about fifty Walloons, who wrought and dyed fine woollen cloths, came into England, and received the royal protection and encouragement. By him the English were first instructed how to manufacture cloth of the best Spanish wool, without any admixture with inferior wool; and also to manufacture and dye fine cloths cheaper by 40 per cent. than they had done before. Ten years before this time, it had been published and admitted in England, that "Spanish wool alone could not be wrought into cloth." It may seem truly extraordinary that the English, who had so long carried on the manufacture of woollen cloth, had not availed themselves of the revolution in Flanders, which drove away the best master manufacturers, to encourage their settlement in this country. M. Huet explains the fact in a way which is not very creditable to the liberality of the English manufacturers, or to the wisdom of our institutions. "It was owing to the municipal laws of England, and its usages towards strangers; who, besides being doubly rated at the custom-house, were excluded from all companies or fraternities of trade; and were

not allowed to carry on manufactures as masters or partners, unless such as the natives were unacquainted with; so that none of the Flemish master manufacturers of fine cloth went thither (to England), their's being a mystery not accounted new, though very much superior to the cloth working then known in England. It was only those who wrought in new kinds of worsteds, ferges, damasks, or stockings, who went thither. The same policy was also adopted by the Hanse towns: hence the greater part of the vast and profitable trade, which was lost to Antwerp, centered necessarily in Holland, where the manufacturers from Brabant were cordially received." This appears a satisfactory explanation why the English, in 1668, were so much inferior to the Dutch in the manufacture of fine cloth.

In the year 1660, however, our manufacturers began to be aware of the superiority of Spanish wool, and to mix it with the best English, probably in what were called medleys or mixture-cloths, or else employing the English wool for warp, and covering it with weft of Spanish wool. The best Spanish wool was then 4*s.* and the second sort 3*s.* per pound, and the best English 1*s.* 6*d.* per pound.

It is deserving of notice, that, in the latter period of the Commonwealth, our trade is said to have greatly revived, but to have suffered a miserable depression almost immediately after the restoration of Charles II. In a letter of M. Downing of the Hague to the president of the council in London, 1660, printed in Thurloe's State Papers, vol. vii. p. 848. it is stated, that great quantities of wool were brought secretly from England to Holland; and he adds, that the Dutch had at that time got in a great measure the manufacture of fine cloth, and would probably, with Silesia, engross also the manufacture of coarse cloth, and leave England nothing but its native wool to export.

In the year 1662, great complaints were made against the merchant adventurers for their neglect of the cloth trade; in reply to which they said, that the demand for English cloths failed in the foreign markets, the white clothing trade having abated from 100,000 cloths annually to 11,000. In the year 1663 our whole exports were only about two millions, and our imports four, leaving a balance of two millions against this country. It is, however, deserving notice, that the number of wardens for the inspection of stuffs at Norwich being too few, they were at this time increased from five to eight. A letter on the state of trade, published in 1667, says, clothing-wools were so much fallen at that time, that the best Spanish was sold at 2*s.* 2*d.* per pound, and English at 8*d.* per pound. The writer ascribes the fall in the price of English wool to our wearing so much Spanish cloth, a great part not manufactured by ourselves, as Dutch blacks; but it is obvious, from the price of Spanish wool, that the low price of clothing-wools at that time depended on a more general cause, affecting all manufacturing countries. To relieve the cloth trade from the great depression under which it laboured between the years 1660 and 1678, various schemes were devised. Among others, the mayor and common council of London passed an act "for the regulation of Blackwell-hall, Leaden-hall, and Welsh-hall, (the three public markets for cloth in London,) and for preventing foreigners buying and selling!" By foreigners are understood all persons not free of the city of London. This act, a most singular monument of the ignorance or selfishness of its authors, prohibits the sale of all woollen cloths sent to London, except at the above halls, where certain duties were to be paid upon them, and from whence they could not be removed for three weeks, unless they were sold in the meantime to some draper, or other freeman of the city. The hall-keepers were to attend strictly at the halls, and

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turn out all foreigners and aliens coming to purchase cloth; and every freeman of the city who should introduce a purchaser into the halls not free of the city should forfeit, for the first offence, five pounds,—for the second, ten,—and for the third, fifteen pounds! Thus, in those days, turning purchasers out of the public markets, and securing the sale to a certain class of buyers, was considered an act for the benefit of the public.

The Irish had, a little before this time, commenced the manufacture of woollens and worsteds, which appears greatly to have alarmed the English manufacturers. The wools of Ireland had increased in quantity, in consequence of a tyrannical act passed a little before this period, to prevent the Irish from sending cattle to England, which obliged them to convert their grounds into sheep-pastures. They were, however, prohibited from exporting their wool to foreigners, it being made felony; and the exportation to England, in any other than a raw state, exposed it to confiscation. About the year 1640 some clothiers from the west of England established a woollen manufacture at Dublin, where it flourished a considerable time. About the same period, sixty families of manufacturers from Holland settled at Limerick: these were ruined by the wars which ensued. Other English clothiers settled at Cork and Kinfales; a few French manufacturers of druggets settled at Waterford; and a more considerable establishment of the cloth manufacture was formed at Clonmel, supported by the capital of some London merchants, who had agents there. These establishments, though obviously inadequate to the supply of one-fourth part of the population of Ireland, excited great jealousy in the English manufacturers; and during the great depression of the woollen trade between the years 1660 and 1668, a part of this distress was ascribed to the rivalry of the Irish clothiers. The English farmers, at the same time, ascribed the low price of wools to the great importations of wools from Ireland; and the merchants ascribed the failure of the foreign demand for cloth to the clandestine exportation of English and Irish wools.

Sir William Petty, in the year 1672, estimates the sheep in Ireland at four millions, and the weight of each fleece at two pounds. The latter, however, is obviously not more than half the true average weight of the fleece, and the number is supposed by some to be below what it was a few years afterwards. If the number of sheep be correct, and taking the fleece of each at four pounds, this would make the total amount of Irish wools only 66,000 packs, of which three-fourths were consumed in Ireland.

The alarm and jealousy excited in England by the Irish woollen manufactures produced measures that almost compelled the Irish to export their wools clandestinely to the continent. An act was passed in the year 1699 prohibiting the exportation of woollen manufactures from Ireland, except to a few parts in England and Wales, where the duties imposed amounted to a total prohibition. Various addresses have been presented to the king and both houses of parliament, "beseeching his majesty to take effectual measures to prevent the growth of the woollen manufactures in Ireland." The Irish parliament was influenced to impose a duty in the same year of four shillings in the pound on their own manufactures when exported. These unjust proceedings were intended to annihilate the export trade for Irish woollens; and, in consequence, their wool and worsted yarn that was not consumed at home were sent to England, or to the continent clandestinely. The first four years after the destruction of their manufactures, these exports to England were as follow:

	Stone of Wool, 18lbs. per Stone.	Stone of Yarn, 18lbs.	Total of Wool and Yarn.
1700	336,292	26,617	362,909
1701	300,812	23,390	326,202
1702	315,473	43,648	359,121
1703	360,862	36,873	397,735

The average annual amount of wool and yarn, as above, may be stated at thirty thousand packs. But after this period the exports to England declined, owing no doubt to the clandestine exportation of wool to the continent, for which the numerous creeks and harbours offered such facility.

In 1711, and the three following years, the quantity exported to England was as under:

	Wool.	Yarn.	Total.
1711	310,136	52,273	365,409
1712	263,946	60,108	324,054
1713	171,871	68,548	240,409
1714	147,153	58,147	205,800

A few years after this, the decline was still more considerable in the amount of wool exported, but that of yarn continued to increase a little:

1726	51,371	87,261	138,632
1727	58,182	72,047	130,229
1728	49,784	80,428	130,212
1729	38,667	91,854	130,521

A further encouragement to clandestine importation was given by an impolitic duty of 2s. 4d. per stone on wool sent to England, which, as the average price did not exceed 6s. 6d., was full thirty per cent. on the first cost. It will be seen subsequently, that the woollen manufactures of England were all this time progressively increasing, so that the decline in the imports of wool from Ireland were not occasioned by a declension of trade; the Irish had found other markets for their wool.

From a work entitled "A New Discourse of Trade," by Sir Joshua Child, supposed to have been published about the year 1667, we learn several important particulars respecting the woollen trade. "Though our vent for fine cloths and stuffs to Turkey, Italy, Spain, and Portugal, were, he says, declined, yet we retained a considerable part, principally because the wool of which our middling coarse cloths are made is our own, and consequently cheaper to us than the Dutch can steal it from us." In another part he judiciously observes, that the acts for regulating manufactures, resolve themselves at last into a tax on the commodity, without respect to the goodness of it, as most notoriously appears in the business of aulnager, which doubtless our predecessors intended for a scrutiny into the goodness of the cloth; and to that purpose a seal was invented as a signal, that the commodity was made according to the statute; which seal, it is said, may now be bought by thousands, and put upon what the buyers please. Sir Joshua Child admits that wool was eminently the foundation of English riches, and that all possible means should be used to keep it within the realm; but the only efficacious measures to effect it are not penal statutes, but encouragement to trade. The impediments at that time he states to be, 1st, The high rate of interest; 2d, Want of hands, which an act of naturalization would cure; 3d, Compulsion (persecution) in matters of religion. For he adds, "while our neighbours the Dutch have money at lower interest and more hands, by reason of general liberty of conscience, with other free privileges, both to natives and foreigners, there is no question but they will be able to give a better price for our wool than we can afford ourselves, and they that can give the best price for a commodity shall never fail to have it by one means or another, notwithstanding the opposition

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opposition of any laws by sea or land; of such, force, subtilty, and violence, is the general course of trade."

The same enlightened writer appears to have been the first Englishman who saw the injustice, absurdity, and impolicy of the numerous restrictions by which the manufacturers were obliged to make cloths of certain weights and lengths, to keep only a certain quantity of looms, or to prohibit dyers, fullers, &c. from carrying on other branches of the trade. "It would be (he justly observed) for the advantage of the trade of England, to leave all men at liberty to make what cloth and stuffs they please, how they will, when and where they will, and of any lengths or sizes."

One of the principal causes of the decay of our woollen manufactures Sir Joshua Child might not think it prudent to state. This was the encouragement given to the consumption of French cloths and woollens in England, together with the total prohibition of English goods imported into France, or the imposition of duties which amounted to a prohibition. The French, under the administration of Colbert, had been extending and improving every branch of the woollen manufacture, and were become our great rivals in foreign markets, as well as at home. In the year 1678, acts were passed, the 29th and 30th of Charles II., prohibiting the importation of French commodities for three years. From this time trade began gradually to revive, and would have greatly increased, had not political causes operated as a check to our prosperity.

The improvements introduced in the manufacture of fine cloths by Brewer in 1668, and the more extensive consumption of Spanish wool, enabled us to oppose, with some success, the rivalry of the French.

After the accession of William, our manufacturers, who were warmly attached to the cause of religious liberty, being the greater part Protestant dissenters, were animated to uncommon exertions in the restoration of their trade. This is evident from the state of our exports in the following year after the revolution in 1689, when they amounted to near seven millions, of which the woollens were nearly three millions. This is the largest amount till the year 1715. A short time after the revolution, about the close of the century, our writers on Political Arithmetic, Mr. King and Dr. Davenant, give the following estimate of our national wealth, including wool, &c.:

	£
The annual income of England, of which the	
people subsist - - - - -	43,000,000
Yearly rent of land - - - - -	10,000,000
Value of wool yearly shorn - - - - -	2,000,000
Woollen manufacture of England - - - - -	8,000,000
Woollen manufactures exported - - - - -	2,000,000

From this period, the woollen trade of England kept progressively increasing, though subject to some fluctuations. In the following years the amount exported were as under:

		£
1718	value of woollens exported	2,673,696
1719	- - - - -	2,730,297
1720	- - - - -	3,059,049
1721	- - - - -	2,903,310
1722	- - - - -	3,384,842

About the year 1722, the plague at Marfeilles, by preventing the exportation of French woollens, increased the demand for English manufactures considerably. In the year 1737, the woollen exports amounted to 4,158,643^l.; and it is remarkable, that at that period the price of wool was uncommonly low.

The yearly medium value of woollen exports,	£
from 1739 to 1748, or to the peace of Aix-la-Chapelle, was - - - - -	3,327,057
Yearly medium of woollen exports, from 1749 to 1753, was - - - - -	4,189,195

From this time to the period of the American war in 1775, the woollen manufactures, and particularly the worsted, still continued to increase, with occasional checks. The quantity of long combing-wools grown in England had given to the manufacturers of worsted goods a decided advantage over those of France, though the ingenuity of the latter in the manufacture of les petites draperies, as the worsted goods are called, was greatly superior to what our own workmen had ever shewn. The demand for worsted goods at home, for tammies and stuffs, which were the general dresses of females before the year 1775, was very great; besides which, we supplied with worsted goods many of the southern parts of Europe, and particularly Spain and Portugal, for the use of their South American colonies, and for the dresses of the clergy, monks, and nuns, which form no inconsiderable part of the population in those countries. About the year 1775, the introduction of Arkwright's inventions for spinning, carding, &c. into the cotton trade, produced a great change in the article of female dresses in England, stuffs and tammies being supplanted by cotton goods, which were become extremely cheap. The failure of the foreign trade also greatly affected our manufacturers, both woollens and worsteds. The price of English wool at the latter end of the American war was lower than it had been in any period of our history, when money was of much higher relative value. A tod of 28lbs. of the best Lincolnshire wool for combing was not worth more than nine shillings, and the inferior kinds six shillings, or about three-pence and four-pence *per* pound. From the time of Elizabeth to the middle of the last century, scarcely any alteration or improvements had taken place in the processes of manufacture, either in woollen or worsted, beyond the variation of colours or patterns, to suit the fashion of the day. The ingenious mechanical inventions of Arkwright, applied to the spinning and carding of cotton, were soon after modified, and applied to the woollen and worsted trade, and produced an entire revolution in some of the seats of their manufacture. Before that period, the manufacture of heavy woollens and coarse worsted goods had been gradually concentrating into Yorkshire and Lancashire, where the cheapness of living, the active industry of the inhabitants, and, above all, the cheapness and abundance of coal, gave the manufacturers a decided advantage over those in the midland and western counties. The following table, shewing the amount of broad and narrow cloths made in the West Riding of Yorkshire, will prove the fact most decisively. It may be proper to remark, that eighty years since, about 1738, when our woollen exports exceeded four millions sterling, the total number of pieces of broad and narrow cloth made in Yorkshire was only fifty-six thousand nine hundred. At present our woollen exports are only about double what they then were; but the number of cloths manufactured in Yorkshire is not less than four hundred and ninety thousand pieces, or eight times more than the quantity made at the period above referred to. It must be remarked also, that this account does not include the cloth manufactured in Lancashire, and the borders of Cheshire adjoining Yorkshire, nor the blankets, serges, baizes, flannels, cassimeres, tolinets, carpets, rugs, worsted goods, or any other description of woollens or worsteds, except plain and narrow broad-cloths. The total amount of these different woollen articles exceed, we believe, in weight, if not in value, that of the woollen cloths.

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An Account of the Number of Broad Cloths, milled at the several Fulling Mills in the West Riding of the County of York, from the 24th of June, 1725, (the Commencement of the Act,) to the 12th of March, 1726, and thence annually, distinguishing each Year; and of the Narrow Cloths, from the 1st of August, 1737, (the Commencement of the Act) to the 20th of January, 1738, and thence annually, distinguishing each Year; likewise the Number of Yards in Length, made each Year, from Easter Sessions, 1768.

Years.	Broad.		Narrows.		Years.	Broad.		Narrows.	
	Pieces.	Yards.	Pieces.	Yards.		Pieces.	Yards.	Pieces.	Yards.
1726	26671				1772	112370	322391 $\frac{3}{4}$	95539	237751 $\frac{1}{2}$
1727	28990				1773	120245	363561 $\frac{1}{4}$	89874 $\frac{1}{2}$	2306235
1728	25223 $\frac{1}{2}$				1774	87201	2587364 $\frac{3}{4}$	88323	2133583
1729	29643				1775	95878	2841213	96794	2441007
1730	31579 $\frac{1}{2}$				1776	99733	2975389	99586	2488140 $\frac{1}{2}$
1731	35563				1777	107750	3153891	95786	2601583
1732	35548 $\frac{1}{2}$				1778	132506	3795990	101629	2746712
1733	34620				1779	110942	3427150	93143	2659659
1734	31123				1780	94625	2802671	87309	2571324
1735	31744 $\frac{1}{2}$				1781	102018	3099127	98721	2671397
1736	38899				1782	112470	4458405	96743	2598751
1737	42256				1783	131092	4563376	108641	3292002
1738	42404		14495		1784	138023	4094335	115500	3356648
1739	43086 $\frac{1}{2}$		58848		1785	157275	4844855	116036	3409278
1740	41441		58620		1786	158792	4934975	123025	3536889
1741	40364		61196		1787	155748	4850832	128740	4058157
1742	44954		62804		1788	139406	4244322	132143	4208303
1743	45178 $\frac{1}{2}$		63545		1789	154134	4716460	145495	4409573
1744	54627 $\frac{1}{2}$		63065		1790	172588	5151677	140407	4582122
1745	50453		63423		1791	187569	5815079	154373	4797594
1746	56637		68775		1792	214851	6760728	190468	5531698
1747	62480		68374		1793	190332	6054946	150666	4783722
1748	60765		68080		1794	190988	6067208	130403	4634258
1749	60705 $\frac{1}{2}$		68889		1795	250993	7759907	155087	5172511
1750	60447 $\frac{1}{2}$		78115		1796	246770	7830536	151594	5245704
1751	60964		74022		1797	229292	7235038	156709	5503648
1752	60724		72442		1798	224159	7134114	148566	5180313
1753	55358		71618		1799	272755	8806688	180168	6377277
1754	56070 $\frac{1}{2}$		72394		1800	285851	9263966	169262	6014420
1755	57125		76295		1801	264082	8699242	137231	4833534
1756	33590 $\frac{1}{2}$		79318		1802	265660	8686046	137016	5023754
1757	55777 $\frac{1}{2}$		77097		1803	266785	8942798	139575	5023996
1758	60396		66396		1804	298178	9987255	150010	5440179
1759	51877 $\frac{1}{2}$		65513		1805	300237	10079256	165847	6193317
1760	49362 $\frac{1}{2}$		69573		1806	290269	9561178	175334	6430101
1761	48944		75468		1807	262024	8422143	161816	5931253
1762	48621		72946		1808	279859	9050970	144624	5309007
1763	48038 $\frac{1}{4}$		72096		1809	311239	9826048	151911	5951762
1764	54916		79458		1810	273664	8671042	158252	6180811
1765	54660		77419		1811	269892	8535559	141809	5715534
1766	72575 $\frac{1}{2}$		78893		1812	316431	9949419	136863	5117209
1767	102428		78819		1813	369890	11702837	142863	5615755
1768	90036		74480		1814	338869	10656491	147474	6045472
1769	92522	277166 $\frac{7}{8}$	87762	2144019	1815	330310	10394466	162355	6649859
1770	93075	2717105	85376	2255625	1816	325449	10135285	120901	5650669
1771	92782	2966224 $\frac{1}{2}$	89920	2235625	1817	351122	10974473	132607	5233616

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In the table that will be afterwards given, it will be seen that the quantity of yards of different woollen articles exported, which are not included with cloths, greatly exceeds that of broad and narrow cloths. Taking this as a standard, it would appear that the cloth returned at the fulling-mills in the West Riding of Yorkshire is not more than one-third of the total quantity of woollens and worsteds of every description made in the West Riding of Yorkshire, and the borders of Cheshire and Lancashire. Now to make the quantity of broad and narrow cloth given in the returns of the West Riding, would require about one hundred and ten thousand packs: we may therefore state the annual consumption of wool in these districts to be from two hundred and fifty to three hundred thousand packs of 240 pounds each; and we may further state the amount consumed in these districts to exceed that of all the other parts of England and Wales collectively by one-third, including hosiery and all other articles made of wool. This will make the total amount of wool manufactured in England to be nearly what we have before estimated, or five hundred thousand packs.

The number of persons immediately employed in the various branches of the woollen manufacture in England was stated, in the year 1800, to be 1,500,000, and that the trade directly and collaterally employed double the above number. This was asserted in the speech of Mr. Law, now lord Ellenborough, in the house of lords, as council for the petitioners against the export of wool to Ireland. But we apprehend that the statement greatly exceeds the actual number employed in this trade, including their families.

The amount of the population of the West Riding of Yorkshire is nearly ascertained, and perhaps two-thirds of the whole may be engaged in the woollen manufacture, including the families of the persons employed. If we state these to be 340,000, exclusive of the woollen manufacturers in Cheshire and Lancashire, we shall certainly not under-rate them. A large part of the West Riding being agricultural solely, and in the manufacturing districts cutlery, as at Sheffield, and cottons in the more western parts, employ no considerable portion of the people. If then we take 340,000 as the amount of persons, with their families, engaged in the woollen trade in the West Riding, exclusive of Lancashire and Cheshire, and if we suppose that they are one-third of the total number of persons employed in the same manufacture in England, it will make the whole rather exceed 1,000,000 of manufacturers, including their families, which we apprehend is not far from the true estimate. We shall, however, give the precise words of Mr. Law's speech in the house of lords on the above occasion, the object of which, it must be recollected, was to enhance the importance of the woollen manufacture. "In order to give your lordships some idea of its magnitude, I may venture to state, that there are no less than 1,500,000 persons who are immediately concerned in the operative branches of this vast manufacture; and if what Dr. Campbell states in his 'Political Survey of the Kingdom' be true, that from the wool-grower to the consumer a piece of broad-cloth passes through 100 different hands, and that there are nearly the same number of hands dependent on the woollen manufacture, though not actually concerned in it, I may assume that the trade directly and collaterally employs double the above number of hands, or 3,000,000. If we estimate the magnitude of this question (the export of wool) according

to the number of persons interested in it, it goes to nearly one-third of the entire population of this kingdom, estimating that population at what is generally reckoned, namely between 9 and 10,000,000." Though the woollen manufactures of England have considerably increased within the last fifty years, we do not apprehend the number of hands employed is greater than before the introduction of mechanical inventions for carding, spinning, and combing. The working up of one pack of wool, particularly of combing-wool, formerly employed a great number of hands, and was divided into small portions, to be spun in the houses of cottagers in remote districts. This afforded employment to the wives and families of labourers who were engaged in agriculture; but so much time was occupied in taking out and collecting in the work, that at the period we refer to, few, if any, of the master manufacturers in Yorkshire consumed more than one pack of wool *per week* in their trade. At present there are numerous manufacturers in Yorkshire and Lancashire, who consume from twenty to fifty packs of wool *per week*.

The cotton manufacture, which may be regarded as of recent date, has employed the population that would otherwise have been thrown out of work in the woollen trade since the introduction of machinery, and has prevented any inconvenience of this kind from being felt at present in Yorkshire. We may, however, observe, that many branches of the woollen and worsted trade have been gradually retiring from the south of England, and concentrating in the West Riding of Yorkshire and in Lancashire. These districts were the first to introduce mechanical improvements into the woollen manufacture, and thus gained a decided advantage over the more ancient seats of the woollen trade. For several years afterwards the effects were felt in the manufacturing districts in the west of England, and great distresses from want of due employment for the labouring classes was the consequence.

At present all kinds of machinery that have hitherto been applied to wool are extensively employed in the west of England, and the manufacture of superfine cloth is in a flourishing state in the counties of Gloucestershire, Somersetshire, and Wiltshire, all ancient seats of the clothing trade. The manufacture of broad-cloth in other parts of the south and west of England is not carried on to any great extent. The manufacture of flannels, serges, baizes, &c. though branches of the woollen manufacture, are distinct from the cloth trade, and seldom carried on in the same district.

The export of woollen goods of all kinds from England, in the year 1815, amounted in declared value to ten millions one hundred and ninety-eight thousand pounds. This was rather an extraordinary quantity; and in the following year the exports fell under nine millions, which may be taken as the regular annual amount of woollen exports at present.

The following table gives the amount of different kinds of woollens exported, with their value, and the places to which they were sent in the year 1816; a year in which our foreign trade was considered as in a declining state. It may be worthy of remark, that though our woollen exports scarcely reached eight millions and a half, the amount taken by the United States of America in that year exceeded three millions; a fact which proves the vast importance of the American market to our manufacturers.

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An Account of the Quantity of Woollen Goods exported from Great Britain, in the year ending the 5th possible, the various Articles,

Countries to which exported.	Quantity and declared Value of Woollen									
	Cloths of superfine, second, and inferior Quality.		Napped Coatings, Duffies, &c.		Cassimeres.		Baizes of all Sorts.		Flannel.	
	Quantity.	Declared Value.	Quantity.	Declared Value.	Quantity.	Declared Value.	Quantity.	Declared Value.	Quantity.	Declared Value.
	Pieces.	L.	Pieces.	L.	Pieces.	L.	Pieces.	L.	Yards.	L.
Russia - - - - -	79671	777074	27	153	2180	19857	128	565	62436 $\frac{1}{2}$	5633
Sweden - - - - -	56 $\frac{1}{2}$	979	—	—	1	4	—	—	832	54
Norway - - - - -	588	4921	217	949	60	378	27 $\frac{1}{2}$	165	4335	389
Denmark - - - - -	717	7447	34	130	354	2308	—	—	8142 $\frac{1}{2}$	646
Poland - - - - -	2	45	—	—	—	—	—	—	100	10
Prussia - - - - -	83	1100	67	324	214	1544	3	18	1324	137
Germany - - - - -	9274	54042	27740	110457	27882	103534	200	580	144972	9494
Holland - - - - -	9892	53294	13374	63462	2374	9367	1741	11950	37928	3373
Flanders - - - - -	3164	23086	6586	29540	1575	7364	13	94	44555	4602
France - - - - -	73	721	—	—	67	910	$\frac{1}{4}$	3	1944	154
Portugal, &c. - - - - -	39854	292141	7466	38755	3931	30037	13114	80377	14859	1355
Spain, &c. - - - - -	3395 $\frac{1}{2}$	30286	1228	5071	930	5975	5584	38139	42554	4411
Gibraltar - - - - -	4344	32520	1270	6805	950	5415	883	4886	79720	8913
Italy - - - - -	7729	45360	2772	11765	658	3395	48	285	20623	1535
Malta - - - - -	8453	45964	1305	5466	811	4274	53	198	4730	537
Turkey and Levant - - - - -	185	2850	51	258	—	—	—	—	1450	160
Ireland and Isle of Man - - - - -	21734	327049	61	399	4008	60851	91	556	200707	18898
Isles, Guernsey, Jersey, & Alderney - - - - -	991	13975	93	515	20 $\frac{1}{4}$	194	140 $\frac{1}{2}$	540	25054	2213
Asia - - - - -	19433	407614	170	936	231	2777	330	1374	225487	28130
Africa - - - - -	1485 $\frac{1}{2}$	17396	498	2538	1122	6586	241	1460	14386 $\frac{1}{2}$	1209
America; viz. United States - - - - -	195124	1463028	19798	73143	39899	263284	4446	12787	2288758	187940
— British Northern Colonies - - - - -	32412	246504	1827	5544	2248 $\frac{1}{2}$	15442	1051	4227	484129	35971
— West Indies - - - - -	16649 $\frac{1}{4}$	114544	529 $\frac{1}{2}$	1926	2708	16991	8109	40098	69729	6451
— Foreign Continental Colon. - - - - -	33319	238796	5409	30863	2911	18888	13926	80236	12999	895
— Honduras - - - - -	30	337	—	—	50	312	—	—	700	53
Total - - - - -	488658 $\frac{3}{4}$	4201073	90522 $\frac{1}{2}$	388999	95184 $\frac{3}{4}$	579687	50129 $\frac{1}{4}$	278538	3792454 $\frac{1}{2}$	323163

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of January, 1817, distinguishing the Countries to which exported, and also distinguishing, as far as and their respective Value.

Goods and Yarn exported from Great Britain.

Blankets and Blanketing.		Carpets and Carpeting.		Stuffs, Woollen or Worsted.		Stockings, Worsted.		Sundry Articles consisting of Hosiery not described, Rugs, Cover-lids, Tapes, &c.	Woollens, mixed with Cotton.		Woollen and Worsted Yarn.		Total declared Value of the preceding.
Quantity.	Declared Value.	Quantity.	Declared Value.	Quantity.	Declared Value.	Quantity.	Declared Value.	Declared Value.	Quantity.	Declared Value.	Quantity.	Declared Value.	
Yards.	L.	Yards.	L.	Pieces.	L.	Doz. Prs.	L.	L.	Yards.	L.	Lbs.	L.	L.
6742	885	30863	6335	2261	4723	208 0	276	1234	12433	2188	—	—	818923
58	7	1240	421	15	25	4 9	9	21	—	—	—	—	1520
268	37	645	155	479	1096	41 4	62	319	1715½	426	—	—	8897
382	51	1047	297	891	1850	10 0	13	152	786	270	—	—	13164
180	20	1130	265	52	120	—	—	—	—	—	—	—	460
—	—	1832	485	188	382	3 0	3	1028	2260	652	—	—	5673
12660	1285	73579	17742	37748	80244	3936 9	5201	15052	135862	26041	—	—	423672
7690	600	28737½	5462	31447	62391	8636 10	10384	3986	19730½	3968	—	—	228237
6663	685	6162	754	5635	13326	5145 6	6499	3645	31785	9072	—	—	98667
15	4	352	88	345	1112	196 0	240	443	2338	686	—	—	4361
44745	5026	18043	3394	27472	72091	3417 0	4153	35206	25190	5919	—	—	568454
10152	1189	6064	1086	11644	29281	2840 0	3666	25931	5846	1505	—	—	146540
2150	219	2600	474	10659	24874	892 10	1029	13846	19593	4563	—	—	103544
570	68	2765	627	14852	37930	62 0	84	1060	2894	720	—	—	102829
100	15	317	83	3682	9603	87 0	113	693	3382	389	—	—	67335
650	70	13595	3366	1816	4222	20 0	42	104	—	—	—	—	11072
30500	4727	46894	12042	8150	20883	12453 0	14156	11582	121483	25444	523638	65613	562200
4280	638	7211	1555	837½	2319	650 6	916	280	548½	150	—	—	23295
23824	3956	9879	2312	187820	572325	629 0	1039	8863	4044	895	—	—	1030221
14190	1237	3718	645	1638½	3353	1520 0	1477	1139	2940	813	—	—	37853
1265746	165729	526964	109529	202061	609628	69059 6	75513	47802	198268	21284	—	—	3029667
258359	32455	69563	14293	21362	55511	18709 4	22190	8995	24103	4410	8757	2086	447628
233597	22153	3080	768	13094	27649	837 6	1133	4916	215912	14973	—	—	251602
39320	3750	9946	2008	9810	21845	2483 0	2851	7746	54805	9928	—	—	417806
1860	120	—	—	14	28	7 0	11	—	—	—	—	—	861
1964701	244926	866226½	184186	593972¾	1656811	131849 10	151060	194043	885918½	134296	532395	67699	8404481

WOOLLEN MANUFACTURE.

If we state the amount of woollen goods exported to be about one-third of our own consumption, or from one-third to one-fourth, which is probably more correct, this would make the total value of manufactured woollens to exceed thirty millions annually. Of the woollen goods exported, the quantity consumed on the European continent scarcely exceeds three millions sterling in value, and a great part of that amount given in the preceding account was for army cloth. Hence it appears, that a very small proportion of the general population of Europe is indebted to this country for its woollens, including under the term both woollen and worsted goods. The increased demand for woollens of every description in England arises partly from the increase of population, but more from the increasing demand for articles of luxury or convenience. In the middle of the last century, carpets were scarcely to be seen in the country, except in the houses of the nobility; at present almost every house in England, except those of cottagers and the labouring classes, has carpets spread in some of the rooms. The consumption of worsted yarn in articles of furniture, and in the linings of carriages, and what is called horse millinery, is very great; add to which the people of England are better dressed than they were formerly. We may from all these causes state, that the home consumption of woollens, in proportion to our population, is double that of any other nation in Europe. To prove that we do not over-rate the proportion of woollens consumed at home, it may be sufficient to state, that the West Riding of Yorkshire alone manufactured, in the year 1817, nearly twice as many pieces of cloth as were exported in that year; but few woollen broad-cloths are made for exportation in the west of England, the manufactures there being principally fine and superfine cloth for home consumption, the value of which *per yard* on the average is much greater than that of the Yorkshire cloth. In the present state of Europe, we think it an encouraging circumstance to our woollen manufacturers, that so large a proportion of their goods are consumed at home, where the demand will remain certain; and again, that the United States of America take so considerable a part of our exports, as from the increasing population of these states, we may expect that the demand will be increasing for many centuries, and will soon exceed what it will be in the power of this country to supply.

In the year 1800, the woollen manufacturers of England were greatly alarmed at the liberty which was intended to be granted, of exporting wool to Ireland, and petitioned parliament against the measure. The grounds on which their alarms rested, were partly the preference given to the Irish, and partly the supposed facility that would be afforded to smuggling wool to the continent. Several manufacturers and wool-dealers from different parts of the kingdom were examined before the two houses of parliament; but neither in their evidence, nor in the speeches of the learned council, who were heard in support of the petitioners, can we trace any comprehensive or enlightened views of the subject. The objections urged against the export of wool were grounded principally on the practice of former reigns, particularly those of Edward III. and queen Elizabeth: but the facts we conceive were in opposition to the statements; for during the whole of the latter reign, in which our woollen manufactures were in a highly flourishing condition, the export of wool was freely admitted, on the payment of certain duties; and during the reign of Edward III., the prohibition to export wool under heavy penalties was confined to denizens and foreigners, in order to secure a larger amount of duties to the king, the former paying less duty on exports than natives; nor was it till the reign of Charles II. that the ex-

port of wool was strictly prohibited. All the former prohibitions were evadable by licences, which were readily granted for money. It is from this reign, therefore, we must date the prohibition to export wool, as forming an established law of the land; and it is not unworthy of remark, that immediately after this period, and to the time of the revolution in 1688, our woollen manufactures were in a very declining state, which proves that they had not derived much benefit from the measure. The policy of admitting the export of wool has been again recently agitated in parliament, and has renewed the alarm of the manufacturers. It is not by precedents drawn from former ages, but solely by the wisdom and justice of the measure, as applicable to one present condition, that a question of this kind should be determined. With respect to short or clothing wool, we believe that a permission to export it would not produce the least effect, as we already import these wools from almost every nation in Europe; it is not, therefore, probable, that foreigners would give a better price for them than our own manufacturers can afford. With long combing-wools, the case is somewhat different, as by the acknowledgment of the French themselves, these wools are wanted to mix with and improve their own. We apprehend, however, that as much is exported at present clandestinely in the form of worsted yarn, as the market may require, the free export of cotton yarn giving great facility for evading the penalty, by packing them together. The permission to export wool to Ireland, which was granted in 1800, has not been attended with any one of the fatal effects which our manufacturers anticipated; nor do we apprehend, that permitting the free export of wool under certain duties would be found to injure our own woollen trade.

In taking this view of the subject, which we trust is an impartial one, we readily admit that the permission to export wool, were it granted, would not be attended with any permanent benefit to the landed interest. A small pamphlet on the subject, recently published by John Maitland, esq., contains the following judicious observations:—"The manufacturer of our native wool claims from government the preservation of it for his use; for *by the statute law of the land, he is confined to its soil for the express purpose of working up the wool which grows upon it.* This wool cannot, therefore, upon any just or moral principle, be permitted to go out of the country in an unmanufactured state, without allowing the manufacturer to follow it, or without obliging the grower and exporter of it to maintain him and his children." This is so obviously just, that whenever the export of wool is admitted, we cannot any longer, as at present, prohibit the woollen manufacturers from emigrating and carrying their industry to the best market. "The wool," as Mr. Maitland elsewhere observes, "does not on an average compose more than one-sixth part of the value of the animal on which it grows; and the manufacturer, by obtaining this sixth part, at such a moderate rate as may enable him to sell his goods, when manufactured at a reasonable profit, insures to the owner of land a moral certainty of obtaining the full value for the remaining five-sixths, and receiving an ample price also for all the other productions of his ground." The truth of this observation we know to be fully proved in the Yorkshire markets. Whenever there is any considerable depression of the woollen trade, it is always attended with a decreased consumption of animal food, supplied principally from Lincolnshire, and the counties which produce the largest quantity of wool. Should the permission to export wool be attended with any effect in diminishing our own manufactures, the result would be highly injurious to the land-owner, who would then have to find new customers for his

WOOLLEN MANUFACTURE.

his general produce, and new associates to share with him the burden of taxation.

The prices of heavy combing-wool in Lincolnshire, Nottinghamshire, or Leicestershire, may be taken as the average price of this kind of wool over the whole kingdom, there being little variation in the value of this wool from different districts. The following table will shew what have been the prices for a great part of the last century :

Price *per* Tod of Lincolnshire Fleeces, the Tod weighing 28 lbs.

	£	s.	d.
1706	-	0	17 6
1707	-	0	16 6
1711	-	0	13 0
1713	-	0	17 0
1714	-	0	18 0
1715	-	0	18 0
1716	-	0	19 0
1717	-	1	3 0
1718	-	1	2 3
1719	-	1	2 0
1720	-	1	0 0
1721	-	1	0 0
1722	-	1	0 0
1723	-	0	17 6
1724	-	0	16 0
1725	-	0	16 0
1726	-	0	15 9
1727	-	0	16 0
1728	-	0	18 0
1729	-	0	18 0
1730	-	0	18 0
1731	-	0	19 0
1732	-	0	19 0
1733	-	0	18 6
1734	-	0	16 0
1735	-	0	14 0
1736	-	0	14 0
1737	-	0	14 0
1738	-	0	13 6
1739	-	0	13 0
1740	-	0	14 0
1741	-	0	14 0
1742	-	0	15 0
1743	-	0	19 6
1744	-	1	1 0

From the year 1744 to the year 1777, the prices, though occasionally fluctuating, continued much the same as in the preceding years, but we have not the means of ascertaining precisely what they were in each year. The following table will shew the prices of Nottinghamshire and Leicestershire heavy combing-wool, taken from the most authentic source. We consider the value of this wool to have been fully equal to that of Lincolnshire on each year.

Price *per* Tod of 28 lbs. of Nottinghamshire and Leicestershire heavy Combing-Wools.

	£	s.	d.
1777	-	0	18 0
1778	-	0	15 0
1779	-	0	11 0
1780	-	0	11 6
1781	-	0	10 6
1782	-	0	9 0
1783	-	0	12 0

	£	s.	d.
1784	-	0	16 0
1785	-	0	12 0
1786	-	0	13 0
1787	-	0	17 6
1788	-	0	17 0
1789	-	0	18 0
1790	-	0	18 0
1791	-	0	19 6
1792	-	1	2 6
1793	-	0	18 0
1794	-	0	17 6
1795	-	0	19 0
1796	-	1	1 0
1797	-	1	0 6
1798	-	0	18 0
1799	-	1	1 6
1800	-	1	4 6
1801	-	1	10 0
1802	-	1	10 0
1803	-	1	9 0
1804	-	1	12 0
1805	-	1	13 6
1806	-	1	12 0
1807	-	1	4 6
1808	-	1	4 6
1809	-	1	8 0
1810	-	1	10 0
1811	-	1	5 0
1812	-	1	10 0
1813	-	1	14 0
By the end of the year	-	2	5 0
1814	-	2	2 0 to 2 12 0
Spring of 1815	-	2	16 0
1815	-	2	10 0
1816	-	1	10 0
1817	-	1	14 0 to 2 0 0

The above were the average prices of the best lots ; the inferior ones might range from one to two shillings *per* tod under the prices here given. It may be observed, that the price of this kind of wool was lower towards the close of the American war, or about the year 1781 and 1782, than in any former or subsequent period of our history, if we take into consideration the relative value of money. At that time, the quantity of wool unfolded in the hands of the farmer was nearly equal to three years annual growth ; a quantity too large to have been consumed by our manufacturers, had not the introduction of machinery enabled them to work it up with much greater facility than formerly. The average weight of these fleeces may be stated at four or seven pounds each fleece to the tod of 28 pounds. Since the commencement of the present century, the price of this kind of wool, it will be seen from the above table, has been amply sufficient to remunerate the wool-growers ; and we confess we are utterly at a loss to discover on what grounds of sound policy or interest they would wish to make any change in the laws respecting the export of wool. With respect to short or clothing wools, any change in the existing laws would make no alteration whatever in the price ; for it is the extreme of prejudice to assert, that our native clothing fleeces are necessary to the foreign manufacturer, either to supply his demand or improve the quality of his own wool. We might with equal justice revive the absurd opinion, so confidently maintained a few years since, that the best Spanish wool would not make cloth without an admixture with that of England.

WOOLLEN-MANUFACTURE.

WOOLLEN Manufacture, Process of. In an early part of this work, under the article CLOTH, we have given a general view of the process of cloth-making, furnished by a principal manufacturer in the west of England. In the present article, we shall confine our account chiefly to those improvements in the processes which have since been introduced, and shall add a description of the machines which were only slightly noticed in the article CLOTH, and give references to the plates. The processes of the woollen manufacture may be classed under two heads; those by which wool is prepared for the weaver, and those by which the cloth is finished after it is taken out of the loom. The sorting of wool has already been referred to under the article WOOL. English wool is supposed to be sufficiently cleaned from pitch marks or other extraneous substances by the wool-sorter, and left by him in a proper state to commence the process of cloth-making. Spanish wool in the bale has generally some part of the pitch employed to mark the sheep still adhering to it, which must be carefully cut off. It was till recently the practice to beat the wool with rods, in order to shake out the dust and open the staples; but this is now principally done by an opening machine with long coarse teeth, called a devil, or wool-mill. Spanish wool is frequently so hardly pressed together in the bag, that it requires to be opened out by beating, to prepare it for the further processes.

In the west of England, wool is generally scoured before it is dyed or carded; but in Yorkshire this is seldom practiced on wool intended for white cloths, and among the smaller manufacturers who dye their own wool, it is frequently put into the dyeing-vat unscoured; a practice which injures the brightness of the colours, but which enables the manufacturer to make a greater weight of cloth with the same quantity of wool. There is also some saving of labour and expence; but this is more than counter-balanced by the increased quantity of oil *per* pack required for unscoured wool, which is at least one-third more than would be necessary if the wool were scoured. In the west of England, where the wool is scoured previously to its manufacture, the process is carried on with a degree of neatness and cleanliness, which form a perfect contrast with the horrid stench and disgusting filthiness of the woollen factories in Yorkshire. For fine cloths, olive-oil, called Gallipoli, from the part where it was supposed to be sent, is principally used; and for the coarser cloths rape-oil. Where attention to colour is not required in very coarse goods, fish-oil is sometimes employed; but if the latter remain in the wool or cloth, it turns it brown, undergoing a degree of fermentation injurious to the cloth, and which sometimes occasions spontaneous combustion. To lessen the expence of oil for coarse cloths, some manufacturers in Yorkshire make use of a mixture of soap and water with oil, which answers very well in moist weather, if the wool be immediately carded and spun; but if it remain some time unwashed, or the weather be very hot, the mixture evaporates. It has been attempted to work wool without any oil whatever, but without success. The use of oil is to cover the surface of the fibres, and enable them to slide easily over each other in carding or spinning. What we have before said of the structure of the surface of wool or hair, under the article WOOL, will suffice to shew the advantage that must result from oiling. The wool is sprinkled with oil as evenly as possible. In Yorkshire the proportion on fine wool is about six gallons *per* pack, and this is more equally distributed over it by the wool-mill, through which it passes previous to the process called scribbling. This process is a kind of coarse

carding, and is performed on a machine similar to that used for scribbling cotton, but larger, and with coarser cards, the principle being similar to that of the carding-machine, hereafter to be described. By this engine the longer fibres are broken down, and they are all laid straight and nearly parallel to each other. The wool leaves the roller of the scribbling-mill in one thin undivided sheet, and the more clear, even, and transparent it appears when held between the eye and the light, the more perfectly has the operation been performed. On the carding-engine, the operation is repeated on finer cards; but instead of leaving the machine in one continued sheet, it is finally divided into separate portions, which by a fluted roller are formed into separate round pieces about one inch in diameter, and two feet three inches in length. The fibres are now arranged so as more easily to slide over and twist round each other in the next process, which is a kind of coarse spinning called slubbing, performed with the slubbing-machine, which will be described. On this machine each of the rolls from the carding-machine are joined together, and drawn out into a loosely-twisted thread, and wound round a spindle, forming what is technically called a *slubbing*. These slubbings being taken to the spinning jenny, which will also be described, are twisted in an opposite direction, and drawn out into threads of yarn of the requisite length. For very fine yarn used in shawls, a machine called the mule is sometimes employed, nearly similar to the cotton mule (see *Manufacture of COTTON*), the slubbing passing through rollers which assist in drawing out the thread smaller and more regular. The yarn is now prepared for winding, sizing, warping, and weaving. (See CLOTH.) Since the article CLOTH was written, broad-cloth is almost universally woven by one person only in a loom, making use of the fly-shuttle. (See WEAVING.) The next process is scouring and burling, already described under the articles CLOTH and FULLING. The cloth is then sent to the fulling-mill; the finer kinds are prepared for fulling by a mixture of soap and water; in coarse kinds, fuller's-earth supplies the place of soap. (See FULLING-Mill, and a farther description at the end of the article.) The principle on which the felting depends has been described under the article WOOL. By the process of fulling, the cloth becomes shortened in length and breadth, and the fibres are incorporated and intimately united with each other. In the best manufactured cloths, this incorporation is so complete, that the separate threads can scarcely be distinguished, the bottom of the cloth appearing to form one even continuous substance. An improvement in this respect has recently been made at Leeds, by spinning the wool much softer and thicker than has usually been the practice, and uniting the threads in the fulling-mill, and then working the substance of the cloth down to a requisite degree of thinness by the gig-mill, hereafter to be described. At the end of the process, the face or surface of the cloth is much softer, and greatly superior in appearance to cloth manufactured in the common process. A pack of wool of 240 lbs. will make when milled about one hundred and twenty yards of mixed or coloured cloth from fifty to sixty inches in breadth, according to the quality and fineness of the wool. The process of raising, shearing, and pressing, have been mentioned under the article CLOTH, and will be more fully described when an account is given of the gig-mill and shearing-machine. The object of these processes is to cover the thread with a soft pile, consisting of the fibres of the wool, cut down to an even surface over the whole piece.

There are various kinds of woollen goods worked on the same principle as cloth, and made with both the warp and the weft

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west of carded wool, but which being unmilled, or finished in a different manner, receive different names. Blankets are manufactured on the card, but from wool that possesses a greater length of staple, and which therefore admits of a deeper pile, being raised on the surface. The yarn is spun thicker, and left as soft as possible, in order that it may form a full cover or pile. Fine blankets are made much flouter and heavier than coarse ones; they are both scoured in the mill, but are scarcely suffered to undergo the fulling process. Thick cloths with a long pile, called duffields, fearnoughts, and bear-skins, are manufactured on the same principle as blankets, but they are milled much thicker and dyed, and also raised to a deeper pile. Flannels and very light cloths, such as Bath coatings, are usually spun small, in proportion to the quality of the wool. In weaving plain cloths, the chain or warp is equally divided by the gears, one half of the threads being above and the other half below, and they cross each other every time the thread of the west is thrown through by the shuttle. In weaving kerseymeres or cassimeres, on the contrary, the warp is unequally divided, to produce what is called the twill, or twel, (see WEAVING,) one-third being always above and two-thirds below the shuttle as it passes. It is owing to this arrangement of the warp, that it forms a slanting or diagonal rib across the body of the cloth, which is the distinguishing character of this kind of woollens. See *DRAUGHT of Looms*.

Cassimeres are usually set in the loom from thirty-four to thirty-six inches wide, and milled to twenty-seven inches. Forty pounds of wool from the bag will make rather more than sixty yards of common milled fine cassimeres; the double milled ones make less in proportion to the degree of milling they receive.

Swandowns and toilinetts are made with a cotton warp; the west is woollen or worsted yarn of various colours, according to the patterns required. Woollen cords have also the warp of cotton and the west of woollen; they are woven and cut precisely in the same manner as cotton cords. See *FUSTIAN*.

Serges are made with the warp of worsted and the west of coarse woollen yarn, and are twilled. These goods have been for a very long time manufactured extensively in Devonshire, and are principally purchased by the East India company for the China trade.

Carpets have worsted warps and woollen wefts. See *CARPET and WEAVING*.

From the most remote period of the woollen manufacture until the latter end of the last century, or about the year 1780, very few, if any, mechanical improvements had been introduced into it. During the whole time the various processes were carried on nearly in the same manner, but with greater or less skill, and were employed upon materials more or less valuable. The carding and spinning of wool, and the weaving and finishing of cloth, in the early part of the reign of George III., were effected by the same machines as in the time of Edward III., which probably were similar to those of the ancient Romans, but more rude in their construction. In an art which had seen so many centuries roll on without any change, it did not appear possible to the manufacturer that any improvement could be effected; and had not the genius of Hargreaves and Arkwright changed entirely the modes of carding and spinning cotton, the woollen manufacture would probably have remained at this day what it was in the earliest ages of civilized society. That it would have been better for general society if it had so remained we readily admit; but after the improved modes of working cotton were discovered, this was impossible. The spinning jenny, which was the same as that employed in

the cotton manufacture, but somewhat larger, was introduced into Yorkshire from Lancashire about the year 1780, but did not become general till about three years afterwards. In the first jennies, not more than eighteen or twenty threads could be spun, and the mode of winding the thread upon the spindle was very imperfect. The carding was still effected by the hand, and the slubbing or roving was prepared on the common spinning-wheel. For some time considerable difficulty was experienced in carding by machinery, particularly in clearing the wool from the card; and a slight change in the construction of the machine was found necessary to prepare the wool for the slubbing-billy, of which an account will be given in the description of the carding-machine. Soon after this, the carding and spinning of wool and yarn by machinery became general through the manufacturing districts of the West Riding of Yorkshire, and large mills were erected, in which the carding and scribbling machines were turned by a water-wheel, and the roving or slubbing performed on the billy. The wool carded at these mills was sent to the smaller manufacturers in the state of slubbing, and the farther process of spinning was effected on jennies in their own premises. Before the year 1787, the old processes of carding by the hand, and spinning on the wheel, were entirely discontinued in Yorkshire; but it was some years after before the new processes were generally introduced in the west of England, and thus, as we have before stated, the woollen trade became more concentrated in Yorkshire, where cloths could be manufactured at less expence. About this time, machinery began to be applied to the combing and spinning of long combing-wool, to make worsted yarn. See *WORSTED Spinning*.

In consequence of the great increase of trade in Yorkshire, it was found difficult to obtain situations for mills to be turned by water, and the application of the steam-engine to woollen machinery became very general. The abundance of fuel was highly advantageous to the Yorkshire manufacturer; and it was found to be equally cheap to work the machines by steam as by water, where any considerable rent was paid for the water. The motion of the improved steam-engine was also rendered as regular as a water-wheel, and the great inconvenience and loss from the interruption of the works by frosts or continued droughts were thereby avoided.

The smaller manufacturers in Yorkshire were at first benefited by the introduction of machinery, but in a little time large capitalists began to engage in the woollen trade, and performing all the processes with their own machinery, they were enabled to work cheaper and undersell the smaller makers. The facility also with which wool could now be worked up kept the markets always well stocked with goods, and prevented the manufacturers from taking the advantage of a temporary scarcity or a brisk demand, which they had formerly done, an overstocked market always reducing the profits.

Soon after the year 1800, the number of small manufacturers began rapidly to decrease many of them, being ruined by the change which had taken place, and compelled to become workmen in the factories of the large capitalists.

The gig-mill and the shearing-machine were not introduced into Yorkshire until they had been several years employed in the west of England, owing to the resistance made to them by the working cloth-dressers or croppers in the north.

The manufacture of worsted is properly a branch of the woollen manufacture, and noticed as such in our history of its progress in England; yet the mode of manufacture, both in preparing the worsted yarn and finishing the goods, being entirely

entirely different from woollens made of carded wool, and part of it being applied to hosiery, we refer, for a further account of it, to the articles *WORSTED Manufacture*, and *WORSTED Spinning*.

Description of the Machines employed in the Woollen Manufacture.—The *wool-mill*, or *willy*, is the first machine which is employed on the raw wool to open and disentangle the close matting, in which the wool comes from the wool-stapler. It is also used for clearing the dyed wool from the dye stuff, and again for mixing different parcels of wool together; also for incorporating the oil with the wool.

The wool-mill used in Yorkshire consists of a cylindrical drum, about three feet long and two feet and a half diameter, which is made to revolve near three hundred times *per* minute. Its circumference is furnished with teeth or spikes, and immediately above it five small rollers are placed, which are also furnished with similar teeth. The teeth of the rollers and those of the drum intersect each other when they all turn round; and the teeth of the five small rollers also intersect each other. The cylinder and rollers are inclosed in a box or case, which is closed on all sides, except a door in front, which turns down, the hinges being at the lower side. When this door is shut up it stands in a perpendicular plane, very near to the teeth of the drum; when the door is opened, or turned down into the horizontal position, the wool is laid upon it, about one pound weight at once, and the door being closed the wool is brought within reach of the teeth of the cylinder, which take the wool and carry it upwards, so as to work it between the teeth of the cylinder and those of the five rollers placed over it. This effects the opening of the wool, and breaks the fibres if the staple is too long: it also separates the matted fibres. In about three seconds, the pound of wool is generally sufficiently worked, during which time the cylinder has made about fifteen turns. The lower part of the case in which the cylinder revolves is a grating of wooden rods, through which the dirt and dust escape. The cylinder is fitted very close to this grating, so that the wool cannot escape from the cylinder, but is carried round in it, and is thus repeatedly submitted to the action between the teeth of the cylinder and those of the rollers. When it is judged that the wool is sufficiently worked, the door is opened again, and the centrifugal force throws out the wool in an instant; a fresh charge is then laid upon the door, and shut up in the machine. A preferable mode is to have two doors on opposite sides of the case; one to put in the raw wool, and the other for the finished wool to come out at.

The wool for coarse goods is passed several times through the wool-mill; first, to break the mats of the raw wool and render it light; then a second time after it is dyed; a third time to mix the different sorts together; and lastly, after the wool is oiled, it is passed a fourth time through the wool-mill, with a view to incorporate the oil well with the fibres of the wool.

Scribbling-Machine.—This is the first stage of carding. The operation tends to disentangle the fibres which were before closely entangled, and draw them out separately, so as to render the wool light and flaky. The scribbling-machine is very similar to the carding-machine, having a large cylinder or drum, which is covered on the surface with sheets of leather stuck full of projecting wire-teeth, called card-wires. The teeth are so close together as to cover the whole surface of the cylinder, like the bristles of a brush. This cylinder is turned rapidly round by the machinery, and the wool is regularly and slowly supplied by feeding machinery to its teeth, which take it up, and the cylinder, as it were, clothes itself with wool. This wool is carded or worked by

the teeth of several other smaller cylinders, called workers and clearers, which are fixed around the great cylinder in pairs. The teeth of the workers take the wool from the great cylinder, and give it to the clearers, which return it again to the great cylinder. It is then transferred to another worker, and by its clearer is given back to the great cylinder, and so on. It is by the repeated transferring of the wool from one cylinder to another, that the chief action of scribbling or carding is performed. The teeth of the different cylinders do not actually touch each other, but they work so near together, that the fibres of the wool which the teeth of one card contains are caught by the teeth of the other card, and drawn out a very few at a time. This action tends to separate the fibres, and renders the wool light and open, and also distributes the wool with great evenness over the surfaces of the cylinders. After the wool has passed between three or four pairs of workers and clearers, it is taken up by a cylinder, called the doffer, which is smaller than the great cylinder, and turns round very slowly. The wool is stripped off from this doffer by a steel comb, which is situated parallel to the axis of the doffer, and is moved rapidly up and down by a crank through a small space. In ascending, the comb does not touch the doffer; but when the comb makes its down stroke, it comes in contact with the teeth of the cards, and combs out almost all the wool they contain. As the doffer turns round very slowly, and the comb acts at small intervals, the successive portions of wool which it combs or strips off, hang together in a continued fleece or web of a very thin texture, which hangs down from the doffer, and is received in a basket.

The wool in this state is said to be scribbled, but the fibres are not yet sufficiently combed out or separated; for on examination of the scribbled wool, many small knots and films of wool are found, which are still closely entangled. The scribbling is therefore repeated twice or three times, and then the wool undergoes another operation, which is called carding, but which is very nearly the same as the scribbling, only the wool is formed into small cylindrical rolls, which are the first rudiments of a thread.

We have thought it needless to give a drawing of a scribbling-machine, as it may be readily conceived from the following description of the carding machine.

Carding-Machine. (See Plate IV. *Woollen Manufacture*.)—A is the wood frame of the machine, but the best machines have cast-iron frames; C C is the outside of the large cylinder, which is about thirty inches diameter, and twenty-six inches wide: its axis is supported on bearings at each side of the frame, and it is put in motion by an endless strap applied upon a pulley at one end of its axis, which pulley cannot be seen in the figure. The cylinder revolves about 100 times *per* minute. B is an arch of wood to receive screws, which support the six small cylinders marked 2 a and 2; these are the workers and clearers. The workers 2 a are larger, and turn slower than the clearers 2; each worker is acted upon by its clearer, and both worker and clearer act against the cards of the great cylinder.

The raw wool is spread evenly upon the feeding-cloth 5, at one end of the machine: it is an endless sheet stretched over two rollers, one of which has a cog-wheel G upon the end of its axis, and receives motion from a pinion situated behind the pulley F. This pulley is turned by an endless cord passing round a pulley n, fixed upon the cog-wheel E, which is turned by a pinion 8 on the end of the axis of the great cylinder. The wool which is spread on the cloth 5 is taken off, between a pair of feeding-rollers, which are clothed with cards laid on in spiral fillets. These rollers cannot be seen, being within the frame; they are about 2½ inches

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inches diameter, and are turned round by toothed pinions on the axis of the cloth-roller, so as to move rather quicker than the feeding-cloth. The feeding-rollers give the wool to a cylinder 4 *a*, called the carrier, which is about nine inches diameter. The carrier works against the cylinder C; but as its surface moves more slowly than the surface of the cylinder, the wool contained in the teeth of the carrier is taken up by the cylinder. The carding-machine represented in our plate is shewn with a cylinder 3, beneath the carrier; this is not used in the present machines, but the feeding-rollers give the wool at once to the carrier 4 *a*.

That part of the cylinder which is adjacent to the carrier moves upwards, so as to carry up the wool it has taken from the carrier, and give it to the workers 2 *a* and clearers 2. The surfaces of the workers 2 *a* move in the same direction as the surface of the great cylinder, but they turn slowly, being put in motion by the chain 9, which passes over wheels at the ends of all the three workers. These wheels have cogs or teeth to enter into the links of the chain, and prevent it from slipping; the chain passes beneath a wheel fixed on the axis of the cog-wheel E, but within the frame. The wheel E is turned by a pinion 8, fixed on the extremity of the axis of the great cylinder; and the proportions are such, that the workers 2 *a* revolve once to about four turns of the great cylinder, and the workers being about 6½ inches diameter, whilst the cylinder is 30 inches diameter, the surface of the cylinder moves about 18½ times as fast as the surfaces of the workers.

The small rollers 2, called clearers, are placed so as to card the wool on the workers, and on the great cylinder also. The clearers are turned round very quickly, and take the wool from the workers, but their surfaces do not move so fast as the surface of the cylinder. Thus the strap 13 passes over a wheel of about 8½ inches diameter, fixed on the extremity of the axis of each clearer; this strap is put in motion by a wheel of about 22 inches diameter, fixed on the axis of the great cylinder; therefore, the clearers turn about 2½ times to one of the great cylinder; but as they are only 3¼ inches diameter, and the great cylinder is 30 inches diameter, the surface of the cylinder moves near 3½ times as fast as that of the clearer. The carrier 4 *a* is turned by the same strap 13; but being larger than the clearers, its surface moves much quicker, so that the cylinder's surface moves only about once and a half as fast as the carrier's surface.

The strap 13 also turns a cylinder 2, at the right-hand end of the machine, called the fly: its surface moves the same way as the surface of the cylinder, but moves nearly once and a half as fast; the pulley at the end of the fly being only 4¼ inches diameter, and the fly itself nine inches. The fly is not placed so close to the cylinder as to take the wool away therefrom, but is intended to raise and loosen it in the cards of the cylinder, so that the cylinder 4 beneath it, called the doffer, can take off the wool more readily. This doffer is 14 inches diameter, and is covered with separate sheets of card-wire, each about 4 inches wide, leaving vacant spaces between them parallel to the axis of the cylinder. The doffer moves round very slowly, its surface moving only $\frac{1}{10}$ of the velocity of the surface of the cylinder: it is turned by a band from a pulley on the axis of the roller D, which we shall next describe.

The comb which works against the surface of the doffer, and strips off the wool from it, cannot be seen in the drawing. The comb is supported by two upright rods, screwed to it one at each end; the upper ends of these rods are guided by two horizontal levers, and the lower ends are jointed to two small cranks formed on an horizontal axis, which is situated at the lower part of the frame near the

ground, and put in rapid motion by a strap, from a pulley at the bottom of the frame beneath the great cylinder. This pulley has a smaller one fixed on the extreme end of its axis, and receives its motion from the same strap 13, which turns the clearers. Every revolution of the cranks causes the comb to rise and fall about two inches; and when the comb descends, the teeth on its edge act against the cards, on the surface of the doffer 4, so as to take out the wool from them. This wool is separated in a continued sheet or film, because the strokes of the comb succeed each other very quickly, and the doffer turns round slowly; but owing to the vacant spaces between the cards on the doffer, this film only continues for a width of about four inches, and is then discontinued until the vacant space on the doffer has passed by the comb, which then acts again to strip off the wool, and so on: hence the wool is drawn off from the machine in a carded state, in small and very delicate films or webs of about 4 inches wide, and 27 or 28 inches long, which is the length of the doffer.

These detached portions of wool are next rolled up so as to form small cylindrical rolls, which is done by what is called the roller-bowl D: it is a cylinder of wood, with shallow flutes upon its surface, parallel to its axis; it is turned round slowly by a pulley H on the end of its axis, and an endless band, 14, which passes round a pulley I, fixed on the wheel E. The lower part of the roller-bowl, D, is inclosed within a hollow cylinder of wood, called the shell; it encompasses the lower half, being fixed beneath the revolving cylinder; the shell is fluted within side, but does not touch the bowl, leaving a small interval between the two. The portions of wool, as they are stripped or combed off from the doffer, fall down over the edge of the shell, which for that purpose is situated close to the doffer, at that part of its circumference where the comb works: by this means, the wool which is stripped off falls down into the space between the shell and the roller-bowl; and when the portion of wool is completely detached and drops off, the motion of the bowl within its shell rolls the wool between them with a rolling motion, which forms the wool into a very round and straight cylindrical roll, called a carding, when these cardings drop out from between the roller-bowl and its shell; they fall upon a flat table, *a a*, as shewn at 7 7 7. This table is covered with an endless cloth, which is stretched over two horizontal rollers; one of these rollers has a cross, marked 16, 16, fixed on the end of its axis; the arms of the cross are seized by a cranked lever, 15, which is fixed to the axis of the roller-bowl, and at every revolution the cross 16 is turned round one-fourth: this moves the endless cloth forwards, and carries the cardings away in the manner shewn at 7 7 7, as fast as they drop out from the shell, and from this table they are carried away to the slubbing-machine, or billy.

In most modern machines the latter movement is altered, the endless cloth being kept in a continual and slow motion by an endless band passing round a small pulley fixed to the pulley H, and a larger pulley fixed in place of the cross 16.

In some old carding-engines many of the motions were performed by toothed wheels and pinions; but of late years all the parts are moved by bands or straps, which produce a much more equable and steady movement. The large cylinders are generally made by placing two or more wheels of cast iron on one axle, the circumference of the wheels being cased with wood, which is attached to them by screws or rivets. The smaller rollers are formed in a similar manner on wooden disks, but all are made hollow, to avoid warping, which would render the action of the cards irregular and uncertain.

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We must now return to the scribbling-machine: it is the same as the carding-machine, except that the breadth of the cylinder is greater, and the teeth are coarser; there is no roller-bowl D, and the doffer 4 is completely covered with cards, without any breaks or intervals; hence the film of wool which is taken off is continuous, and is suffered to fall down into a basket.

Double Scriblers.—In Yorkshire it is common to employ double scriblers; that is, two of the machines combined together, and placed in one frame; there are two large cylinders, each surrounded with its workers and clearers, and doffer, as we have described, making in all seventeen small cylinders. The first great cylinder has a feeding-cloth and carrier, to supply the wool to the cylinder; but the second large cylinder is supplied with wool from the doffer of the first cylinder, which doffer serves in place of a carrier to the second; it therefore has no comb. The doffer of the second cylinder has a comb to take off the wool, which then falls into a basket.

This machine is said to save trouble of attendance, and does more work than two single machines. The usual practice is to pass the wool once through the double machine, and then once through a single machine. A double machine will scribble about a hundred weight of wool *per* day.

After the wool is scribbled it is weighed, and when it is taken to the carding-machine, a certain weight is spread over a certain length of the feeding-cloth, so as to supply the wool to the machine with perfect regularity. The proper weight which should be allowed is ascertained experimentally, according to the fineness of the thread which is required to be spun. The cardings are weighed from time to time, to ascertain if each one contains the proper quantity of wool.

The cardings produced by the united operations of scribbling and carding are composed of fibres of wool laid very lightly together with the least possible entanglement; they are very regular and even in size, and upon this circumstance the perfection of the spinning chiefly depends.

Slubbing-Machine, or Billy.—This performs the first process of spinning. It reduces the cardings, and draws them out in length; joins them together, and gives them a slight twist, in order to form a coarse and loose thread, called a slubbing or roving, which must be spun over again in the jenny, to make a thread fine enough for the loom.

This operation was formerly performed by hand on the common hand spinning-wheel, which is similar to that used for spinning wool, but of a smaller size. Machines were then contrived by which a number of slubbings could be drawn out together; but the aid of the hands was required for joining the rolls or cardings of wool together in succession, and for other purposes, which were found to take so much time, that very little, if any, saving of labour was effected by the use of such machines.

A perspective view of the slubbing-machine, now universally employed, is given in *Plate I. Woollen Manufacture*. A A is the wood frame of the machine; within this frame is a moveable carriage, D D, which runs upon the lower side-rails at a a, with wheels 1, 2, to make it move easily; and it is capable of running backwards and forwards in the frame from one end to the other. The carriage contains a number of perpendicular spindles, marked 3, 3, which are put in rapid motion by a long cylinder F, and a separate band from each spindle, which passes round a small pulley on the spindle. The cylinder F extends horizontally across the whole breadth of the carriage; it is made of tin plate, hollow like a tube, and covered with paper on the outside.

The spindles are placed in a frame, so as to stand nearly perpendicular, at about four inches from each other; their

lower extremities are sharp-pointed, and turn in sockets, and they are retained in their perpendicular position by a small collar of brass for each, which surrounds the spindle at about the middle of its length. The upper half of each spindle projects above the frame, and on the lower part the small pulley or whirl is fixed, to receive the band from the horizontal cylinder, which is about six inches in diameter, and a little longer than the row of spindles; it is placed before them with its centre at a lower position than the row of whirls. The cylinder receives motion by a pulley at one end, with an endless band from a wheel E, made like the large wheel used in spinning wool by hand, and of the same dimensions. The wheel is situated at the outside of the great frame of the machine, and its axis is supported by upright standards erected from the carriage D; the wheel is turned by the left-hand of the spinner, applied to a winch, which is plainly seen in the drawing, and gives motion to the cylinder F, which again turns all the spindles at once with a great velocity.

Each spindle receives a thread, or slubbing, which threads issue from beneath a roller, C C, at one end of the frame, and proceed to the row of spindles placed in the carriage, so that the slubbings are extended nearly in an horizontal direction. The spindles, by the motion of the carriage, are capable of advancing or retreating from the roller C, so as to extend any required length of slubbing.

The cardings of wool, which are to be spun into slubbings, are extended side by side upon an endless cloth, which is strained in an inclined position between two horizontal rollers, one marked B B, and the other cannot be seen. There is one carding for each spindle, and the number is usually from 50 to 80. C is a light wooden roller to bear upon the cardings which lie upon the cloth, and press slightly upon them by its weight. Immediately before this roller is a wooden rail G, and another beneath it, which is fixed horizontally across the frame: the cardings are conducted between these two rails, the upper of which is capable of rising; but when it falls by its weight, it holds the cardings fast between the two, and hence these rails are called the clasp; the upper moveable rail G of the clasp is guided between sliders, and a wire 7 descends from it to a lever 6. When the carriage D is wheeled close home to the end of the machine, a wheel 5 lifts up the end 6 of the lever; and this, by the wire 7, raises the upper rail G so as to open the clasp, and release all the cardings: in this state, if the carriage is wheeled or withdrawn back from the clasp, it will draw the cardings forward. There is a small catch which receives the upper rail G of the clasp, and bears it up from falling until the carriage has retreated a certain distance, and drawn out about eight inches length of the cardings; a stop on the carriage then comes against the catch and withdraws it; the upper rail of the clasp G then falls and holds the cardings fast, whilst the carriage continues to recede, and draw out or stretch that portion of each carding which is between the clasp and the spindle. All this time the wheel is turned to keep the spindles in motion, and give twist to the cardings in proportion as they are drawn out, by which means it is prevented from breaking; because as the carding diminishes in size, and increases in length, the increasing twist combines the fibres of the wool, so as to give strength to the coarse thread or slubbing which is thus produced.

The slubbing is lapped round the spindle, but the clasp being higher than the upper ends of the spindles, the direction of the slubbing is not quite at right angles to the spindle; hence the spindle, when it is turned round, will give twist to the slubbing, without winding or gathering it

up upon the spindle, because the slubbing always slips over the top-end of the spindle; but when a portion of each slubbing is finished, and it is required to wind it up round the spindle in a ball, the slubbing must be pressed down by a wire 8, so as to bear it from the point of the spindle, and place it opposite to the middle part of the cop or ball upon the spindle, and then the motion of the spindle will cause it to wind up upon the spindle, and form a ball.

The wire 8 is made to operate upon the whole row of slubbings at once, and for this purpose a horizontal rail 4 is placed in the front of the row of spindles, being provided with pivots at its extreme ends, on which it is supported in standards rising from the carriage D. It has a small arm or lever projecting from it at each end, and the wire 8 is stretched between these arms. By turning the rail 4 round upon its pivots, the wire is capable of being raised up, as in the figure, or lowered down at pleasure: when the wire is lowered, it descends below the level of the top of the spindles, so as to bear down the threads which, when the wire is raised up, as shewn in the figure, proceed from the points of the spindles.

The spinner holds the rail 4 in his right-hand, and it is by this that he draws the carriage either in or out, according as it may require; and by turning the rail 4 round, he can elevate or depress the wire 8, so as to make it bear down the slubbings to any degree at pleasure; by this means, he distributes the slubbings upon the spindles in a proper manner, to form a regular ball or cop, as shewn in the figure.

As the cardings are very slight and tender, they would be liable to break if they were dragged forwards on the inclined cloth, or even if the cloth were to be moved round its roller by the force applied to the cardings. To avoid this, a cord is applied round a groove in the middle part of the upper roller, and after passing over proper pulleys, as shewn in the drawing, it has a weight suspended to one end, and a smaller weight to the other; the small weight is only to keep the rope tight, but the large weight tends to turn the rollers and endless cloth round in a direction to deliver out the cardings, so that there will be no strain on them. Every time that the carriage is wheeled home, the large weight is wound up by means of a piece of wood projecting from the carriage, which seizes a knot in the cord at the part which lies horizontally; this pushes the cord back a certain distance, so as to draw up the great weight; but the endless cloth cannot turn backwards, because there is a ratchet and click at one end of the roller which prevents it; the rope, therefore, slips round upon the roller. When the carriage retires, the great weight turns the roller and endless cloth round, so as to deliver out the cardings at the same rate as the carriage retreats and takes them up; but when the proper quantity is given out, the knot in the rope arrives at a fixed stop, which does not permit it to move any farther; and at the same instant the roller 5 quits the lever 6, and allows the upper rail G of the clasp to fall, and hold the carding fast from being drawn out any farther; the wheel E is then put in motion to turn the spindles round, and the carriage is drawn back, which extends the slubbings, and twists them at the same time, as before mentioned.

When the carriage is drawn out to its full extent, and the necessary twist is given, the wire 8 is put down to bear down the slubbing from the point of the spindle, and the motion of the wheel being continued, the slubbings are wound up upon the middle part of the cop or ball which is formed upon the spindle; but as fast as the slubbings are wound up, the spinner must push back the carriage towards the clasp; and he must turn the wheel round at such a rate that the

spindles will not wind up any faster than the carriage returns, otherwise the slubbings would be broken or unequally stretched; he must also raise and lower the wire 8 continually, by turning the rail 4 round in his hand, in order to distribute the slubbing on the cop in a regular manner, so as to make a firm ball or cop.

A child attends the machine to bring the cardings from the carding-machine, and place them upon the inclined cloth; and when they are exhausted, fresh ones are joined on, so as to keep the machine constantly supplied.

The degree of twist which is given to the slubbing is regulated by the discretion of the spinner in turning the wheel at a proper rate, corresponding to the quickness with which he draws out the carriage. Slubbings which are intended to be spun into yarn for the warp of the cloth require to be more twisted than the slubbings intended for the weft; but the proper quantity of twist depends on the fineness of the wool, and the length of its fibres. In general it may be stated, that no more twist is given to the slubbings than is necessary to make them draw out to the required extent without breaking. This twist is of no use to the yarn, because the slubbing will be twisted in the contrary direction, when it is spun the second time in the jenny.

An improved slubbing-machine has been introduced, which is put in motion by the mill, and the carriage is made to draw out by the power of the machine. The spinner has only to push the carriage in, and turn the handle, in order to wind up the slubbings; by this means, a greater degree of regularity is attained in the quantity of twist which is given to the slubbings when they are drawn out. The movements to effect this are taken from the mule used in cotton-spinning. See *Manufacture of COTTON*.

Spinning Jenny.—In this machine, the slubbings are spun over again, and reduced to the requisite fineness for weaving. The jenny has nearly the same parts as the billy, but differently arranged. The spindles are placed at one end of the frame, and the clasp which holds the slubbings is placed on the carriage, so that it can be moved backwards and forwards, to and from the spindles by the spinner, in order to draw out and extend the yarn at the same time it is twisted.

A perspective view of the jenny is given in *Plate II. Woollen Manufacture*.

The spindles 3, 3, 3, are placed perpendicularly at about four inches asunder at one end of the frame AA of the machine. The lower extremities of the spindles are pointed, and turn in small cups or sockets in a cross-rail of the frame; they are supported near the middle of their length by passing through brass-collars in a horizontal rail. Near the lower end of each spindle a small pulley is fixed, to receive an endless band, which passes round the horizontal cylinder or roller 2, about six inches diameter. The cylinder is supported on pivots at its ends in the sides of the frame, and lying in a direction parallel to the row of spindles, it turns them all round by a small band for each. This cylinder is usually made of tin-plate, that it may not alter its figure by the weather, as wood would do; and its surface is covered with coarse brown paper, to prevent the bands from slipping upon it. The cylinder 2 is put in motion by a strap or band 1, 1, which passes round a pulley at the end of it, and also round the great wheel BB, which is supported in a framing suspended over the machine from the ceiling, but which is not shewn in the drawing. The wheel B is turned by applying the right-hand to the winch B. In front of the row of spindles, and about a foot higher than their points, a long cross-rail 16 is situated horizontally: it is supported at each extremity by being mortised into blocks of wood cc, which are furnished

with small wheels or castors, forming a sort of carriage, to run horizontally upon the side-beams of the main-frame in grooves, which guide them, so that the rail 16 can be moved backwards and forwards through a space of about six or seven feet, in a horizontal position, without varying from its parallelism with the row of spindles. The underfide of the rail 16 is formed into a number of narrow notches for the slubbings to pass through; and these notches are partly filled up by projecting pieces, rising up from a second cross-rail 5, 5, so as to form the clasp which confines or pinches the slubbings in the notches when the lower rail is raised up; but the slubbings can draw freely through the notches when the lower rail is let down. This lower rail is guided and limited to move up and down only a small space by staples, which project downwards from the rail 16, and receive the ends of the lower rail 5 of the clasp. The rising and falling of the lower rail is effected by small cords fastened to it at about every yard of its length; these cords are conducted over small pulleys (concealed in the substance of the upper rail 16), and are all attached to a handle, situated over the middle of the upper rail at 16, and beneath an arched bar, which is fixed on the top of the clasp. The spinner holds this handle in the left-hand, whilst the right is employed in turning the wheel; and by the fingers of the left-hand she can raise up the lower rail 5 of the clasp, and draw it close to the upper one. It will then be retained in that position by a small spring-catch, and will clasp the slubbings fast in the notches, through which they pass; but when the spring-catch is pushed back, so as to relieve the handle, the lower rail will fall down by its own weight, and release the slubbings, to allow them to slide through the notches.

The cops of slubbings which are to be spun are supported in an inclined frame 4, 4, fastened within the main frame of the machine. The cops are mounted upon iron wires; they are placed in two rows, one above the other, as shewn in the drawing; but each row should only contain half as many cops as there are spindles.

Each slubbing is conducted through a notch in the clasp, and thence it proceeds nearly in an horizontal position to the spindles 3, 3.

When the yarns have been drawn out and twisted they are wound up on the spindles in balls, in a similar manner to the billy. The wire which is used for bearing down the thread from the points of the spindles is marked 12; it is attached to a horizontal rail, which is supported on pivots at its ends, close to the row of spindles. There is a small pulley 11, fixed at one end of the rail, and a short lever at the other, which lever is hidden in the drawing by a part of the framing. Between the pulley 11 and the lever, the wire 12 is extended, and by turning the rail round upon its pivots, the wire will have a motion up or down.

The spinner can communicate motion to the pulley 11 by means of a cord 7, 7, which passes round it, and extends the whole length of the frame, the end being made fast to a pin at A; this cord lies over the surface of one of the blocks 6, which contains the wheels of the carriage, and passes between three small pulleys 9, 6, and 8. The centre pins of the pulleys 9 and 8 are fixed to the block; but the centre pin of the pulley 6 is fixed to a small slider, and can be drawn in the direction of the rail 16, by applying the finger to a small trigger near the handle 16. This action removes the pulley 6 out of the line of the other two pulleys, so as to shorten the cord 7, and turn round the pulley 11; this brings down the wire 12, and bears down the threads upon the spindles. A small counterweight is suspended from the wheel 11, to return the wire to its former position when the pressure of the finger on the trigger is removed. By

this movement, the spinner has full command of the wire 12, to raise or lower it in any degree she thinks proper; and this is done independently of the motion of the carriage, because the pulleys 9, 6, and 8, run freely along the cord 7, and their motion has no tendency to move the wheel 11 either way.

The jenny is worked by one person, who stands within the frame, and turns the wheel B with the right-hand, whilst he holds the clasp in the left, so as to run it backwards and forwards along the frame at pleasure. The slubbings are drawn between the moveable rails 16 and 5, in the notches of the clasp, and each slubbing is fastened on to its corresponding spindle. The clasp being left open is drawn backwards from the spindles, and the slubbings run freely through the notches of the clasp; the slubbings are drawn off the balls at 4, when the clasp retires from the spindles, until a certain length of each slubbing is drawn out and extended nearly in an horizontal position between the spindles and the clasp: this length is regulated by a mark made on the frame of the machine, to indicate when the clasp has arrived at its proper position. The bars of the clasp are then brought together by raising up the handle under the catch, as before described, and it fastens all the slubbings in the notches. This being done, the spindles are put in rapid motion by turning round the large wheel B B; they twist those parts of the slubbings which are extended, and the motion being in a contrary direction to the twist of the slubbing, the first tendency is to untwist the slubbing, at the same time that the carriage and clasp are gently drawn back, or from the spindles. By this means, the slubbings are stretched or drawn out in length at the same time that they get a new twist in the opposite direction; this keeps them from breaking, and when they are drawn to their intended extent by the carriage being moved back to the stops at the extremity of the main frame, the great wheel is turned round as many turns as is necessary to give them all the twist which those portions of thread are intended to have.

The threads extended between the clasp and the spindles are now finished, and it only remains to wind them up upon the spindles, previously to drawing out a fresh portion of each slubbing, in order to spin it in the same manner. To wind up the threads, they are pushed down upon their respective spindles, by pressing the trigger which moves the wire 12; and the motion of the great wheel B is continued, in order to wind up the slubbings in balls upon the spindles, at the same time that the carriage and clasp are pushed back towards the spindles. When the carriage is got home, the thread is finished and wound up, and a fresh portion of slubbing is extended. To do this, the lower rail of the clasp is dropped down, and it releases the slubbings; the carriage is then drawn back to the mark upon the frame, as before described, which shews that a proper length of each slubbing is drawn off from the balls, and extended between the spindles and the clasp. The clasp is then closed, and the wheel B put in motion to twist the threads whilst the carriage is drawn out; thus the spinning operation is repeated as before, and prepares another length of each of the threads. When finished, they are pushed down from the points of the spindles, in order to make them wind up thereon in the balls, as before.

There is some discretion required in spinning with the jenny, to draw out the carriage with a movement correspondent to the rapidity with which the spindles give the twist, or rather untwist, to the slubbing; for the principal extension of the thread is effected whilst the slubbing is untwisting, and whilst the first portion of twist is given to the threads. These motions must be properly proportioned by the

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the spinner, who must also be careful to give an equal degree of twist to each successive portion of thread which is spun, otherwise the thread will consist of hard and soft places.

When the yarn is intended for the warp of the cloth, the spindles are turned for a given time after the thread is extended to its full length, as we have before mentioned; but for the yarn which is to be used as weft, it is different: the whole of the twist is given during the extension of the thread, and none afterwards; this difference is to render the weft softer than the warp, because in the cloth the weft appears more on the surfaces than the warp, and it is principally the felting and interlacing of the fibres of the weft that will form the surface of the cloth when finished.

The yarns are usually extended in the jenny two and a half or three times the length of the slubbings from which they are spun; and that degree of twist given to them which is suitable to the purpose for which the yarn is to be employed.

The *Mule for spinning of Yarn* is very nearly the same machine as the mule for spinning cotton; this is used for spinning some kinds of woollen yarn instead of the jenny. When the mule is employed for spinning yarn for weft, it is used in the same manner as described in our article *COTTON Manufacture*; but for spinning warp, the spindles are made to revolve, and twist the thread some time after the carriage is run completely out, and the stretching of the yarn is finished. There is a movement in the machine that shifts the endless strap which turns the mule upon a larger pulley, as soon as the carriage is run fully out, so as to give a more rapid motion to the spindles after the stretching, or drawing out, is finished, than they had during the drawing back of the carriage. By this means some time is saved, because the spindles may be allowed to run very quick when it is only required to twist the threads; but whilst the extension is going on, the twisting motion must be moderate, or the threads would be broken. A very similar movement is used in the mule for spinning cotton, and is called the double-speed; but the description of this mechanism is omitted in the article *MANUFACTURE*.

The mule has not, till lately, been in much repute for spinning woollen yarn, and the jenny is still thought to spin better yarn: but we have no doubt that when certain modifications are made, it will become a much more perfect method than the jenny, being much less dependent on the discretion and dexterity of the spinner; for if the machine is once constructed so as to spin properly, it will always continue to do so.

To keep the yarn to the size which is intended, a few of the coppins are reeled off, in order to measure out a certain length of the yarn, which is weighed; and if it does not prove of the weight expected, the quantity of wool which is spread over a given surface of the feeding-cloth of the carding-machine must be increased or diminished accordingly; and when the right quantity is formed, the lead weights which are used for weighing the given quantity of wool are altered to suit it. The draft of the jenny may also be altered to effect the same thing.

The spinning processes are now finished, and it remains to weave the yarns into cloth. From the description we have given, it will appear that woollen yarn is spun in a very different manner from cotton. The opening processes and the scribbling and carding are very similar, except that the carded wool, instead of being drawn into a continued sliver like cotton, with the fibres stretched the lengthways of the sliver, is formed into separate rolls, with the fibres disposed crosswise or spirally round the roll.

By the slubbing-machine these are joined together, drawn

out in length, and slightly twisted, by operations similar to that of roving in cotton-spinning; but the operation of drawing, which is so frequently repeated for cotton, would be useless, and to a certain extent even prejudicial for wool. The object of that process is to elongate and stretch the fibres of the cotton straight, and lay them parallel to each other; but it does not reduce the sliver to a smaller size, because as many times as the sliver is extended in length, so many slivers are put together into the drawing-frame at once, leaving the sliver which has been drawn the same size as it was before, but elongated to three or four times the length, and all its fibres fully extended.

As woollen cloth is intended for felting, it is not desirable to straighten the fibres, but only to disentangle all knots, and unfold any fibres which may be doubled, also to lay the fibres in the direction of the length of the thread. There is a natural curl in the fibres of wool which should be preserved, and will contribute to the firmness with which the fibres will entangle in the felting.

The operation of spinning by the jenny and billy are very similar, but both differ from the manner in which the extension is made in the cotton spinning-machines by rollers. In the jenny, the extension is made upon a considerable length of the carding or slubbing at once; but in the rollers, the length of cotton which is submitted to the action of drawing out is very short, indeed very little longer than the length of the fibres of the cotton. In mule spinning both modes of extension are practised; first, drawing the roving by rollers, and then a certain length is stretched out to a greater extent.

Warping.—The coppins of yarn are mounted on wires in a frame, and the yarns are drawn off from them, in order to combine a sufficient number of them together, to form the warp for the web of cloth which it is intended to weave. For instance, for making the cloth called double drab, which we shall take as an example, 2960 threads, each 65 yards long, are laid parallel to each other; but a separation is preserved at every 40 threads, dividing the whole into 74 parcels, for the convenience of the weaver.

The warping is performed by the warping-mill, which is a large reel, with its axis horizontal; the ends of the threads are made fast to the reel, which is turned round, and it draws the threads off the coppins, so as to wind them upon its circumference; and to prevent the different turns of the threads from lying one over another, the threads are guided through an eye or ring affixed to a slider, which is moved along a wooden rail, in a direction parallel to the axis of the reel, by a cord that winds round one end of the axis of the reel.

A warping-mill for silks is described in our article *SILK*, and will give a clear idea of the present, which only differs in the horizontal position of the axis, and in the greatness of its dimensions. The threads for the warp being thus assembled together, are taken off the reel, and rolled up into a bundle.

The warp is then scoured in urine, to remove the greasiness of the wool, and is next sized; to do this, it is dipped into the cauldron of size, about ten yards in length at a time, and well worked in by the hands. After sizing, the yarns are stretched out at length in a field, till they are dry, and the warp is then ready for the loom.

The yarn for the weft is wound off from the cops of the jenny to the quills or small bobbins, which are to be put into the shuttle.

The loom for weaving broad-cloth has the same parts as the simple loom described in our article *WEAVING*; but it is made very strong, to enable it to resist the strain of weaving

such broad and heavy cloth. The fly-shuttle, invented by John Kay in 1737, is now in general use; it enables one weaver to do the work, which formerly employed two men at opposite sides of the piece, to throw the shuttle from one to the other, the width being greater than a man can reach. The warp is wound on the yarn-beam, which is placed in the loom, and the threads being drawn through the beddles and the reed, and fastened to the cloth-beam, the loom is ready for working, in the usual manner of weaving plain cloth. At each edge of the warp a few threads of strong and coarse yarn are placed; these form what are called the lifts when the cloth is woven, and serve to give strength to the cloth, and receive the hooks by which the piece is stretched in the tenters after milling.

The width of the cloth is measured between the lifts and the number of yarns, which we have specified will make 100 inches in width for the double drab-cloth, or for common cloth 3000 threads will make a piece 103½ inches wide. The quantity of weft used for these cloths is upon an average one pound weight to a yard in length. The length of the warp contracts a little in the weaving, so that the sixty-five yards of yarns will make only sixty-two yards of cloth.

Scouring.—The piece of cloth must be cleansed from the greasiness of the oil before it can be felted; for this purpose, it is first soaked three hours in a mixture of urine and pig's dung, it is then scoured in the mill for two hours, and lastly, for half an hour with fair water. The scouring is performed at the fulling-mill by a pair of stocks. (See *FULLING-Mill*.) The pair of stocks are two large wooden hammers, suspended with the helves or handles in an inclined position, and the heads are lifted in succession by cogs or tappets, fixed on the axis of a water-wheel. When the cogs quit the hammers, they fall by their own weight, and strike the piece of cloth, which is contained in a wooden cistern or trough, in which the hammers work. The action of the hammers is to beat and compress the folds of cloth, and to turn the piece continually round in the trough or cistern in which it is placed. The form of the trough is such, that the weight of the piece of cloth causes it to occupy the lower part of the trough, and each hammer when it descends drives the cloth out from this lowest part, and forces it up a curved sweep. When the hammer is lifted up, the cloth falls again into the space which it before occupied, and at the subsequent descent of the hammer it is again driven out; the heap of cloth is of a considerable bulk, and this action of the hammers is chiefly on the lower part of the heap; the beaks of the hammers strike nearly horizontally under it, as it were to undermine the heap, so that the top part falls over when the hammers retreat. This action causes a continual circulation or turning round of the piece of cloth within the trough, and effects the scouring, by continually bending and folding the cloth in a fresh direction; and as the strokes act upon a great number of folds at once, the different surfaces of the cloth are caused to rub against each other, with a very similar action to washing cloth by hand.

When the scouring is finished, the piece of cloth is taken out, and extended in a vertical plane, in a frame called the tenter, where it remains till dry.

The *tenter* consists of a number of vertical posts fixed in the ground with a continued horizontal rail, which is fixed on the top of them, and is as long as the piece of cloth; there is also another line of horizontal rails, which are fitted between the upright posts, so as to slide freely up and down; and they can be fixed at any distance beneath the upper rails by means of pins in the posts, according to the width of the piece of cloth. Both the upper and lower horizon-

tal rails are driven full of tenter-hooks, which are small iron rails sharpened at both ends, and bent at right angles, like an L; on these hooks the lifts of the cloth are fastened, and the lower or moveable rails are fixed at the proper distance beneath the upper rails, in order to extend the cloth to its full width.

Burling.—The cloth being dried is burlled, that is, examined minutely in every part, and all knots and uneven threads or straws, or extraneous matters, removed; any rents or defects which can be found are repaired, by introducing fresh threads. This being done before the milling or felting, the fibres of the new threads will become so entangled as to render such defects nearly imperceptible in the finished cloth.

Fulling-Mill for felting the Cloth.—There is another kind of stocks in a fulling-mill; but the shape of the trough in which the stocks or hammers work on the cloth is different from that described in the article *FULLING-Mill*, which is only proper for scouring. In order to subject the cloth to the blows of the hammers, the trough for milling is formed in such a manner that the cloth cannot escape from them, because that part of the trough which is opposed to the beaks of the hammers is nearly a flat surface, and perpendicular to the direction in which the hammers strike, so that the cloth is actually beaten between the beaks of the hammers and the flat bottom or rather side of the trough.

The hammers are made to strike very heavy blows; but they do not bruise or injure the cloth, because there is always a great number of folds of cloth on which they strike. The helves or handles of the hammers are placed in a different position from the scouring-stocks, in order to make the hammer-heads fall in a more perpendicular direction when they make their stroke, and hence they strike with more force. On this account they are called falling-stocks, whilst those used for scouring are called hanging-stocks, in which the helves of the hammers being nearer to the perpendicular, the heads move in a more horizontal direction, in the manner of a pendulum, and exert less force on the cloth; the other difference is, that the hammers of the scouring-stocks only drive the heap of cloth round in the trough, there being no part directly opposed to the beaks of the hammers but a fair curve, which is so much inclined to the direction in which the hammers move, that the cloth mounts up the inclined curve when the hammer strikes, and evades the direct force of the blow.

There is another kind of fulling-stocks, in which the trough and hammer are constructed with a view to mill or felt the cloth; but the hammers are put in motion in a different manner: thus the helves are suspended in a vertical position, like pendulums, and the force of the cogs on the horizontal shaft, which is turned by the water-wheel, is applied to drive the hammers forwards against the cloth, and produce the felting. To return or draw back the hammers, a chain is attached to each, and these chains are linked to the opposite ends of an horizontal lever, like a scale-beam, which is fixed in front of the stocks. This lever and chains draw back one hammer when the other is pushed forwards; and as the hammers are actuated alternately by the cogs, a constant action is kept up.

The most simple fulling-mill by a water-wheel has no other wheels, but the tappets or cogs which lift the hammers are fixed immediately into the axis of the water-wheel, and it usually gives motion to two pair, one at each side of the wheel. It rarely happens that this construction of a mill allows the water to be used to the greatest advantage, because the circumference of a water-wheel should not move with a greater velocity than between 180 and 240 feet *per* minute;

minute; and the hammers of a fulling-mill should be so timed, that each one will make from about 30 to 36 blows *per* minute. This requires that the cogs for the hammers should be numerous, and fixed in the circumference of a large wheel fixed on the axis of the water-wheel, otherwise the water-wheel must be made to turn so quickly as to lose a great part of its force. A better way is to apply a cog-wheel on the axis of the water-wheel to turn a pinion on the horizontal shaft, which carries the cogs for the hammers, and this horizontal shaft may have a fly-wheel upon it, to regulate the motion and render it uniform.

Mr. Smeaton's proportions for a fulling-mill for two pair of stocks were as follows:—The water-wheel, 14 feet diameter, 7 feet broad; it was a breast-wheel, and the fall of the water was five feet from the surface of the mill-pond to the tail-water below. The spur-wheel on the axis of the water-wheel 72 cogs, and $9\frac{1}{2}$ feet diameter; the lantern turned by it 23 rounds. Upon the same shaft as this lantern was a fly-wheel of eight feet diameter, with a rim of cast-iron seven inches square, and also the two cogs or tappets for each of the four hammers forming two pair of stocks. The same mill was adapted to be turned by the power of horses in dry seasons; for this purpose, another lantern of 13 teeth was applied on the other end of the same horizontal axis, which could be occasionally turned by a horizontal cog-wheel of 90 teeth and 12 feet diameter, fixed on the vertical shaft, which the horses turned. The levers by which the horses drew were 15 feet long, so that the horses' track was 30 feet diameter.

It required four horses to work one pair of stocks in this mill, and when Mr. Smeaton tried the expenditure of water at this mill, and also at another mill with an overshot-wheel, he found it required from 1200 to 1400 cubic feet of water *per* minute, falling one foot, to work a pair of stocks. Taking the force of a horse at 352 cubic feet *per* minute raised one foot, this is very nearly equal to four horses. These stocks were used for fulling of bays, and we apprehend the power for working the fulling-mills for broad-cloth is greater.

Process of Milling.—A piece of cloth of sixty-two yards long has six pounds of soap allowed for it, which is dissolved in water, and a handful spread upon every yard in length; the piece is then put into the trough of the mill, and worked for three hours; during this time the cloth is frequently moved in the trough, to expose fresh surfaces to the action of the hammers. The blows upon the cloth cause a motion of the fibres of the wool amongst one another, and the soap facilitates this motion; the fibres of the wool have the singular property of moving always forwards in the direction of the roots of the hairs, when a number of hairs are rubbed or worked together, but they will not retreat in the opposite direction; this produces the matting or entangling of all the fibres together. After three hours milling, the piece of cloth is taken out of the trough, and soaped again, then returned and milled again for three hours. This is repeated four times, making twelve hours milling in the whole, and then a stream of fair water is admitted into the trough, to wash away the soap. The piece of cloth, when taken out of the mill the last time, is generally found reduced to about 60 inches broad, and 40 yards in length; before the operation, it was 100 inches broad, and 62 yards in length.

The operation of felting is so well explained by M. Monge, in the *Annales de Chimie*, that we think proper to give an extract from his memoir, in addition to what is stated in our articles FELTING, FULLING, and WOOL.

If we examine a human hair, a fibre of wool, or the hair of a rabbit, hare, beaver, &c. in a microscope of the greatest

magnifying power, the surface of each hair appears smooth and even; or at least if any inequalities are perceptible, they seem rather to arise from some difference in the colour and transparency of particular parts of the fibres than from the irregularity of their surfaces; for their images, when viewed by a solar microscope, are terminated by even lines, without any roughness. Nevertheless it is probable the surfaces of these objects are formed either of *laminae*, which cover each other from the root to the point, much in the same manner as the scales of a fish cover the animal from the head to the tail; or still more probably of zones placed one over the other, like what is observed in the structure of horns; to this conformation it is, that such substances owe their disposition to what is called felting.

If with one hand we take hold of a hair by the roots, and draw it between two fingers of the other from the root towards the point, we are hardly sensible of any friction or resistance, nor can we distinguish any sound; but if, on the contrary, we draw it between the fingers from the point towards the root, we are sensible of a resistance which did not exist in the former case. A sort of tremulous motion is also produced, which is not only perceptible to the touch, but may also be distinguished by the ear.

It is evident, therefore, that the texture of the surface of a hair is not the same from the root towards the point, as from the point towards the root. As this texture is the principal object of the present memoir, it is necessary to demonstrate it by some other observations.

If a hair is held between the fore-finger and thumb, and rubbed by them backwards and forwards alternately in the direction of its length, a progressive motion of the hair will take place; but this motion is always with the root forwards, although the rubbing of the finger and thumb is alternately in both directions. This effect does not at all depend on the nature of the skin of the fingers, or its texture; for if the hair be turned, so that the point is placed where the root was, the movement then becomes contrary, *viz.* its motion is always directed towards the root.

What is observed in the above instance is entirely analogous to what happens when country children, by way of sport, introduce an ear of rye between the wrist and the shirt-sleeve; the points of the beards of the ear are directed outwards, and by the various motions of the arm, this ear, sometimes catching against the shirt, sometimes against the skin, takes a progressive motion backwards, but the beards always resist its return, so that it soon gets up to the arm-pit. It is very clear, that this effect is produced by the asperities upon these beards, which being all directed towards the point, do not permit the ear to move in any other direction than towards that part which was united to the stalk. There can be no doubt that it is the same with respect to hair, and that its surface is beset with asperities, which being laid one upon the other and turned towards the point resist all motion, except towards the root.

These observations, which it would be useless to multiply, relate to long hair, which have been taken as examples; but they apply with equal propriety to wool, furs, and in general to every kind of animal hair. The surface of all these is, therefore, to be considered as composed of hard *lamelle* placed one upon another, like tiles, from the root to the point; which *lamelle* allow the progressive motion of the hair towards the root, but prevent a similar motion towards the point.

From what has been said, it will be easy to explain why the contact of woollen stuffs is rough to the skin, while that of cotton or linen cloths is smooth: the reason is, that notwithstanding the flexibility of each particular fibre, the asperities

perities upon the surface of the fibres of the wool, by fixing themselves in the skin, produce a disagreeable sensation, at least till we are accustomed to it; whereas the surface of the fibres of hemp or flax, of which linen is made, being perfectly smooth, do not cause any such sensation. It is also probable, that the injury arising to wounds or sores from the application of wool does not proceed so much from any chemical properties, but is occasioned solely by the form of the surface of the fibres, the asperities of which attach themselves to the raw and exposed flesh, which they stimulate and irritate to such a degree as to produce inflammation.

The asperities with which the surface of wool is every where surrounded, and the disposition which it has to assume a progressive motion towards the root, renders the spinning of wool and making it into cloth difficult operations. In order to spin wool and afterwards to weave it, we are obliged to cover its fibres with a coating of oil, which, filling up the cavities, renders the asperities less sensible; in the same way as oil, when rubbed upon the surface of a very fine file, renders it still less rough.

When a piece of cloth is finished it must be cleansed from this oil, which, besides giving it a disagreeable smell, would cause it to soil whatever it came in contact with, and would prevent its taking the colour which is intended to be given to it by the dyer. To deprive it of the oil it is scoured at the fulling-mill, by working it with hammers in a trough full of water or urine, in which fuller's-earth is sometimes mixed. This earth combines with the oil which it separates from the cloth, and both together are washed away by the fresh water, which is afterwards brought to it in the machine. Thus after a certain time the oil is entirely washed out of the cloth.

The fulling, which succeeds the scouring of the cloth, is aided by the application of the soap. The alternate pressure given by the hammers to the piece of cloth, especially when the milling is pretty far advanced, occasions an effect analogous to that which is produced upon hats by the hands of the hatter; the fibres of wool which compose one of the threads, whether of the warp or the weft, assume a progressive movement with their roots forwards, and introduce themselves among the fibres of the threads nearest to them, then into those which follow; and thus by degrees all the threads, both of the warp and the woof, become felted together. The cloth, having by the above means become shortened in all its dimensions, and thickened in its substance, partakes both of the nature of cloth and of that of felt; for at the same time that the threads give it considerable strength, it may be cut without being subject to ravel, and on that account we are not obliged to hem the edges of the pieces of which wearing apparel is made. Lastly, as the threads of the warp and those of the weft are no longer so distinct and separated from each other as to leave interstices between them, the cloth forms a warmer clothing, independently of its having acquired a greater degree of thickness. Knit worsted is also rendered less apt to run, in case a stitch should drop, by the operation of fulling.

Tentering.—When the milling is finished, the cloth is stretched again on the tenter. It is usual to extend the piece to forty-two yards in length, but not at all in breadth; indeed only one inch of extension in each yard is allowed by law. The cloth remains in the open air until it is perfectly dry and ready for the succeeding operations of finishing, which are only intended to give it a beautiful surface, for it already possesses all the useful qualities of cloth.

Dressing the Cloth with Teafels.—This operation is to raise up the nap or loose fibres on the surface of the cloth, by

scratching it over with a species of thistles called teafels, in order to form a wool on the surface, which can be removed by shearing. The teafels are the balls or ears which contain the seed of the plant called *dipsacus fullonum*; the scales which form the ball project on all sides, and are terminated with sharp points, which turn downwards, like hooks, and are very elastic. See TEASEL.

A number of teafels are put into a small frame, which is composed of a handle eight or ten inches long, having a small stick passed through it at one end about eight inches long, which is split into two at each end nearly all its length. There is also another similar stick, which is passed through the handle near the middle of its length; the two split sticks are perpendicular to the stem or handle, and parallel to each other. The space between them is filled with teafels, which are jammed in very fast between them, and also in the clefts of the split sticks, where they are secured by strings extended between the ends of the split sticks, and twisted, until they draw the sticks forcibly together, and bind the teafels very fast. This frame filled with teafels forms a tool, which very much resembles the curry-comb used to clean horses, and is used in a similar manner, to scratch over the whole surface of the cloth, and draw out all loose ends of the fibres of the wool, which are not firmly confined by the entanglement of the felting.

The dressing is performed by two men, who hold the teasel-frame by its handle, and work the cloth, when it is hung up in a vertical position over two rails fixed to the ceiling; when they have worked over as much surface as they can reach, they draw down a fresh portion, which they work in turn, and thus proceed until they have finished the whole piece. The first time the cloth is dressed it is wetted with water; it is worked three times over in the wet state, by strokes in the direction of the length of the piece, and then it is worked again three times in the other direction; by this means all the fibres are raised, and the cloth is prepared for shearing.

In the most improved manufactories, the dressing is performed by the gig or gig-mill. This is a cylinder covered on its surface with teafels, and turned rapidly round whilst the cloth is drawn over it.

The *Gig-mill* is represented in perspective in *Plate V. Woollen Manufacture*. M is the wood frame of the machine; FF is the cylinder or drum, which is composed of 12 rails or troughs, filled with teafels FF, 3, 4, &c. These are fastened on the circumference of two or three wheels fixed upon a wooden axis 7; the drum is put in motion by a pulley ED at one end of its axis, which receives an endless strap, 2, from the drum C, situated above the machine. There are two pulleys, E and D, one fixed fast on the axis, and the other fitted on loosely, with liberty to turn round freely upon it; the strap can be shifted to either pulley, and accordingly the machine will be put in motion, or will stand still.

The drum C is fixed on one end of an iron shaft 1, which is put in motion by a bevelled wheel B, from the larger wheel A, fixed on the great horizontal shaft, which proceeds the whole length of the mill. The drum, FF, covered with teafels, is mounted on bearings supported by the frame, and the piece of cloth G is conducted over it, to receive the action of the teafels; one end of the piece of cloth is wound round a roller J, and the other end of the piece is wound on the roller L; both these rollers are put in motion from a bevelled wheel 6, fixed on the extremity of the axis of the drum; this turns a wheel H upon an inclined axis, which has a pinion at each end; one of these pinions, 9, turns a bevelled wheel, K, on the end of the axle of the upper roller

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roller L; and the other, 8, turns the wheel I belonging to the lower roller J. By means of this wheel-work both rollers are turned round in the proper direction, to make the upper roller L wind up or draw the cloth, whilst the lower roller unwinds and gives out the cloth. N is a pipe, which conveys water to the machine; it is pierced with a number of holes to throw jets of water on the cloth, and wet it.

As fast as the cloth is taken up by the roller L, it is given out by the other roller J, and is then drawn over the surface of the cylinder, as at G, the teasels of which, as it revolves, act very effectually on the cloth to raise the nap. When the whole piece has passed, and is gathered up on the roller L, the machine is stopped, by shifting the strap z to the loose pulley D, then the two rollers L and J are exchanged, and the operation is repeated as before, and so on till the nap is sufficiently raised.

The mode of repeating the action on the cloth by exchanging the rollers is troublesome, and a better mode is to provide the means of disengaging either of the wheels K or I from its respective pinion, making the machine so that only one wheel and pinion can be engaged at once; also to make the motions in such direction that the roller which is engaged shall always wind up the cloth upon itself. Each roller must have a small wheel upon one end of it, as shewn at 10, with a lever and weight 11, to press upon the circumference of the wheel with such force as to occasion a friction, and make the cloth draw tight when it is drawn off the roller. In this way, the cloth can be made to work either backwards or forwards; because that roller which is engaged with the wheel-work will wind up the cloth, and draw it off from the other roller across the drum; but when all the cloth is wound off, that roller which has taken the cloth must be disengaged, and the other put in action, which will make the cloth work back again.

The most improved gig-mills used in Yorkshire have a still better method of moving the cloth. This is by means of a pair of rollers in the place of the upper roller L: they are turned round by a large spur-wheel on the end of the roller, which works in a smaller wheel on the end of the drum; one roller is mounted over the other, like the two rollers of a flattening-mill, and pressed together by screws with sufficient force to draw the cloth between them. The piece of cloth, when brought to the machine, is laid down on a board on the ground before the machine, and one end is passed under the roller J, which is merely to guide it; then it is carried over the drum, as at G, and introduced between the pair of rollers at L, which draw it slowly forwards; from these the cloth turns upwards, and is extended horizontally over two rollers which are suspended from the ceiling. After quitting these rollers, it descends perpendicularly, and is gathered on the ground in folds on a board or bench, close to the place where the piece of cloth was laid before the dressing was begun. In order to make the piece of cloth pass a second time through the machine, or as many times as is required, the two ends of it are sewed together, so that it circulates continually over the drum without any interruption or trouble: it is usually done three or four times.

It is an advantage of this method, that the cloth, in descending from the ceiling, hangs perpendicularly, and with that side which has been dressed opposite to the light, so that the workman who gathers it in folds can examine the progress of the work; and when he judges that the cloth is sufficiently dressed, he cuts the sewing which unites the two ends together, and then the end of the piece comes out of the machine, and the cloth is carried away to give place to another piece.

The drum or cylinder of the gig-mill is composed of a number of shallow troughs, fixed on the circumference of the wheels of the drum, and parallel to its axis: into these troughs, frames filled with teasels, like those we have before described, are fastened in a very simple manner; and the frames are placed so close together, that the trough is wholly filled, and forms a continuous surface of teasels to act upon the cloth when the cylinder revolves. When the hooks of the teasels become filled with stocks or fibres of wool, which they have drawn out from the cloth, they are removed from the cylinder, in order to be cleaned by children, who pick out the stocks with a small steel comb.

The teasels are cultivated very largely in the clothing countries; but it sometimes happens, in particular seasons, that the crops fail, and they are then very dear. This has produced many trials of metallic teeth as substitutes for teasels. Mr. Price of Stroud, in Gloucestershire, has two patents, dated 1807 and 1817, for this object; Mr. Laffalle of Bristol took a patent in 1816, Mr. Williams of Fursley in 1817, and Messrs. Lewis of Brinscomb in 1817. We are not informed if any of these inventions are yet brought into real use in the manufacturing district.

Shearing or Cropping the Cloth.—By the operation of the teasels, the wool is become raised all over the surface of the cloth in a loose fur, which must be removed by shearing before the cloth will be fit for wearing, because the fur would gather dirt and dust, and would wear very unequally.

The shears used for cropping by hand are the same as those used in the common shearing-machine, and are represented at E, E, in *Plate III. Woollen Manufacture*. The clothier's shears consist of two very large flat blades of steel, united together by a stem of steel, which is bent into a circular bow, and is sufficiently flexible to allow one of the blades to be moved upon the other, in order to make them cut. Both blades are ground to sharp and straight edges, which apply one to the other, but the blades are not in parallel planes like scissars, for one of the blades is laid quite flat upon the cloth, and the plane of the other blade will then be inclined to the cloth at about an angle of 45 degrees, as is shewn in *Plate III*. The cutting-edge of this inclined blade bears upon the surface of the flat blade, and the spring of the bow is so set, as to press the two edges always in contact. The lines of the edges of the two blades are not parallel to each other, but inclined, so that the edge of the upper blade crosses the edge of the lower blade, and bears upon the flat surface of that blade, at the end nearest to the bow, whilst the other end of the edge of the upper blade is removed over the edge of the lower blade, thus leaving an interval between the two edges, when the shears are open, as is plainly shewn in the figure. In this state, the shears being open, if the lower blade is laid flat upon the surface of the cloth, the nap or wool, which is to be removed by the cropping, will stand up above the edge of the lower blade, in the interval between the two edges; then if the blades be forced together, the edge of the upper blade will pass or cross over that of the lower, and cut away all the wool which projects above the edge of the lower blade. The contact of the cutting-edges begins at the end nearest to the bow, and proceeds regularly to the other, because, as before mentioned, the edges are not parallel to each other. The blades open or return to their former position by the elasticity of the bow, but in order to make the cut they are closed by means of a handle or lever 10, which is fitted or lodged on a round part of the stem of the bow, so as to play thereupon as upon a centre of motion. A double cord is made fast to the lever or handle near to this centre, and the

the other end of the cord is fastened to a block of wood, which is screwed to the flat of the lower blade, and rises up to a proper height. By depressing this handle, the shears are closed, and make their cut with the greatest facility, the elasticity of the bow returning the handle.

The manner of cropping with these shears is as follows:— The piece of cloth is laid down in folds upon a plank or low bench placed on the ground, and the end is drawn across a table or bench, which is covered with cloth, and stuffed with horse-hair, like a cushion. The cloth is stretched out flat upon the surface of the table, and is retained by hooks and weights. Two workmen are employed to shear a piece of cloth; they place the lower blades of their shears flat on the surface of the cloth, with the line of the edge in the direction of the length of the piece; one of the shears is laid on the edge or lift of the cloth, and the other exactly in the middle of the breadth of the cloth. The bows and stems of the shears project over the edge of the table, and the workmen place themselves at that edge. Each man guides the shears with his left-hand, and makes the cut with his right. To hold the shears by, a short staff is lashed to the bow of the shears, and secured by a stay to the lower blade; its direction is nearly parallel to the back edge of the upper blade. The workman puts his arm through the bow as far as the elbow-joint, then lays the fore-arm flat against the staff, which he grasps with the hand; and in this way he has a great command of the shears, leaving the right-hand at liberty to work the handle which closes the shears. This handle is moved backwards and forwards with great rapidity, to make cuts or clips on the cloth, and between every cut the lower blade is moved a small space on the cloth, to cut in a fresh part.

The art of shearing consists in moving the shears with great regularity and parallelism, so that every part of the surface shall be equally cropped. The closeness with which the shears cut is regulated by weights laid upon the flat of the lower blade; these press the blade down into the soft cushion on which the cloth is spread, so that the fur will stand up more above the edge of the blade.

As the two shearers advance in their work, their shears proceed across the breadth of the piece of cloth, and when the man who began in the middle has worked to the lift of the cloth, the other who began at the lift will have worked to the middle, where the first began; the whole breadth is now shorn, and they remove the shears, and draw the piece of cloth forwards across the table, to obtain a fresh surface to work upon.

For shearing common cloth, it is cut wet the first time, then it is dressed again with teasels, dried on the tenter, and cut again in a dry state three times over.

Shearing-Frame.— The most common machine used in Yorkshire is only applied to give motion to the same kind of shears as are used for cropping by hand, and is usually called the shearing-frame. At the side of the table or cushion on which the cloth is spread, a long stool is placed, having grooves at the edges to guide the wheels of a carriage, to which the shears are affixed by their bows. There is a carriage for each pair of shears, and they are slowly and gradually moved along the stool, by a cord which winds upon a roller turned by wheel-work; and at the same time, the handles of the shears are continually pulled by a cord connected with a small crank, which turns round very rapidly. The direction of the cuts is the lengthways of the piece of cloth, and the two pair of shears advance across the breadth of the piece until a whole breadth is cut; the machine is then stopped, the shears removed, and the piece of cloth shifted upon the table. These shearing-frames

operate very well, but require great care and attention to make the different cuttings join, in order to cut equally over the whole surface.

The machine invented by Mr. Harmar of Sheffield was of this description; his first patent was in 1787, and another in 1794. At one period his machines were in general use, but the present shearing-frames, although of the same kind, are very much simplified, and work equally well.

A perpetual Shearing-Machine is represented in *Plate III. Woollen Manufacture*; it is used in the west of England, and is best adapted for narrow cloths. The shears lay crosswise over the piece, which is drawn regularly beneath the shears in the direction of its length without any interruptions; hence it is called a perpetual shearing-machine.

The shears, E E, are the same as what we have already described. Each pair is fastened across the frame by means of a piece of wood, to which the lower blade of the shears are screwed; immediately beneath this blade is the cushion to bear the cloth, which passes between the blade and the cushion. The piece of cloth is wound round the roller C, upon the end of which is a wheel N, and a lever M, which bears up against the lower part of this wheel with so much friction as to make the cloth strain tight in drawing off from the roller. The cloth first passes over a rail B, from which it proceeds in an horizontal direction beneath the two pair of shears E E, then turns over another rail at the other end of the frame, and descends to a roller D, which is turned slowly round by the machinery, in order to wind up the cloth.

The machine is put in motion by the endless strap round the drum F upon a shaft, which proceeds all the length of the mill. The strap turns the pulley G upon the end of the small horizontal spindle H: in this spindle two cranks are formed at *a* and *b*, which are connected, by wires 7 and 8, with the handles 9 and 10 of the shears E, so as to give them a continual motion, and make a cut of each pair of shears every time the spindle H makes a turn. The motion of the machine can be stopped by releasing the lever P, on which the bearing of the spindle is screwed: when the lever P is depressed, and kept down by the catch, as represented in the drawing, the endless strap is drawn tight, so as to turn the spindle; but if the catch is removed, and the lever raised up, the strap becomes loose, and slips round upon the pulley without turning it. A small pulley is fixed upon the spindle at I, to receive an endless strap which passes round a larger wheel J. Upon the same axis with this are three other pulleys of different diameters, which receive a strap 2, and give motion to three similar pulleys fixed upon a spindle 3: the latter spindle has a pinion on the end of it, which works a bevelled wheel fixed on the end of the roller D, and thus it is turned slowly round. The three pulleys on the spindles 3 and J are placed reversed to each other, that is, the smallest pulley on one is opposite to the largest on the other; by this means, the same strap 2 may be shifted, and will work on any of the three pair of pulleys, but each one will communicate a different degree of movement to the roller D, and consequently to the cloth, so as to draw it quicker or slower, and make the successive cuts of the shears at a greater or less distance asunder at pleasure.

The cushions which bear up the cloth against the shears are moveable on centres of motion, and are capable of being raised or lowered. When they are lowered down, the cloth can be readily introduced beneath the lower blades of the shears; and when raised up, they press the cloth up to the shears, and the force of this pressure can be regulated by turning a small handle. In many machines this motion is applied

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applied to the shears themselves, instead of to the cushion or bed, and is much more convenient.

The perpetual machines answer very well for shearing narrow cloth, when the shears can cut at once across the whole breadth; and then as the two shears work in succession over the same surface, they crop the cloth twice over in passing once through the machine. It has been attempted to shear wide cloths in this machine, by making one pair of shears take one half the breadth, and the other pair the other half; but it is very difficult to draw a wide piece of cloth so evenly over the cushions, as to keep it stretched to the full breadth without any wrinkles in the lengthways of the piece; and if there are any such wrinkles, the cloth will be cut very irregularly. In this particular, the first machines have the advantage, because the cloth is stretched over the cushion by the workman with discretion, and he makes it tight before the cropping is begun.

There have been many patents for the improvements of shearing-machines. Mr. Buffington's, in 1804, is for a method of stretching or extending the cloth breadthways whilst it is in the shearing-frame. His plan is to attach a narrow web of strong cloth to the lifts of the cloth, by sewing or lacing; the outer edge of this web is also sewed to a cord or small rope, so that the cloth becomes edged or bordered with ropes. These ropes are conducted through holes or openings in the frame, which will suffer the cloth and ropes to be moved in the direction of their length; but as the ropes cannot draw sideways out of these openings, the cloth may be continually stretched in its breadth. The openings should have rollers to facilitate the motion of the ropes.

Mr. Joseph Fryer's patent shearing-machine, dated 1802, acts with three shearing-blades, one long one, which extends across the breadth of the piece to form the lower or fixed blade, and two other moveable blades of half the length, which are jointed to the long blade at the two ends, and are moveable thereon, so as to cut in the manner of scissar-blades. The moveable blades are pressed into contact with the edge of the fixed blade by springs, and are put in motion by means of two cranks upon an horizontal spindle, so that the blades make their strokes or cuts alternately. The edge of the lower blade is a straight line, but the edges of the moveable blades are convex on the cutting side, so as to cause them to intersect the edge of the lower blade always at the same angle when they are wide open, as when they are nearly closed.

The piece of cloth is conducted over proper rollers, and wound up by one, which is turned round by the machine, so as to draw the piece of cloth from one end to the other with a slow and progressive motion. The cloth, when it is immediately beneath the edge of the long blade, is bent suddenly over a narrow ridge of metal, which is parallel with the edge of the lower blade, but so far distant as to permit the cloth to pass between them. This ridge of metal is capable of adjustment by means of screws, and can be placed so that the nap of the cloth will be shorn longer or shorter, as it is required.

In some cases, especially in finishing broad-cloths, instead of drawing the piece from end to end, it may be more convenient to cause it, or part of it, to move under the shearing-blades from lift to lift, or from one side to the other. This will require a machine considerably larger, though the same blades will suffice; or it is found equally convenient to cause the blades, at the time they are cutting, to move over the cloth in any direction, but more especially from lift to lift.

Mr. Fryer also contemplated the finishing of the cloth
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by the same machine which performed the shearing. Thus after the cloth has undergone the operation of shearing or cropping, in its passage down to the cylinder on which it is wound up, it is exposed to a current of steam thrown out from a horizontal tube at a number of small apertures, so as to give softness and pliability to the cloth; a brushing cylinder is next made to move against it, by which the remaining wool or fur is laid in one direction. It then passes between two polished metal cylinders, which are made hollow, and kept hot by the admission of steam or otherwise. These occasion a great pressure on the cloth, and dissipate all the water imbibed from the steam.

Rotatory Shearing-Machine.—A very complete machine for cropping cloth of any breadth was invented by Mr. Price, of Stroud, in Gloucestershire, and for which he obtained a patent in 1815. This machine shears or crops the cloth across the breadth, beginning at one end of the piece, and continuing regularly to the other. For this purpose, the cloth is conducted through the machine by the motion of rollers, and is drawn over a bed or support which lies beneath the stationary or fixed blade of the shears or croppers, (which answers to what is called the ledger-blade in the common shears,) so that the cloth passes between the bed and the stationary blade.

The moving blades of the shears are fixed on the circumference of a cylinder situated above the fixed blade, with its axis exactly parallel thereto, and capable of revolving by the power of machinery, so that the edges of the moving blades will be carried against and passed over the edge of the fixed blade, in order to cut away all the wool of the cloth which rises above the edge of the fixed blade. Several such moving blades are fixed upon the same cylinder, to act in succession against the fixed blade; and these moving blades are placed obliquely to the axis of the cylinder, or in such a manner as to form portions of spirals; but as all parts of the cutting edges are equidistant from the axis of the cylinder, it is manifest, that in the revolution of the cylinder, every part of each spiral edge is brought in succession into contact with the fixed blade, so that in its revolution it crops off all the wool, which by the progressive motion of the cloth over its bed is raised up against the fixed edge. The edges of the moving blades are placed at such a degree of obliquity to the axis of the cylinder, that at the same instant the end of one ceases to cut against the edge of the fixed blade, the following revolving blade will begin its action at the other end of the cylinder; therefore, by the time that any one of the revolving edges has passed over and made its cut against the whole length of the fixed blade, and is ready to quit it, the succeeding revolving edge is brought into action, and when this has passed, the next in succession begins, so as to keep up a continued action.

The cloth is stretched in width by a contrivance which he calls stretching-bands, to prevent it getting into folds or wrinkles, which would be injured by the shears, or make irregularities in the shearing. These stretching-bands are endless straps or bands, each of which is extended over two wheels. The bands have sharp pins projecting from them to prick into the lifts at the edges of the cloth, and the bands being so situated that one of them lies exactly beneath each lift, they will be caused to circulate round their respective wheels by the motion of the cloth. The stretching of the cloth is effected by the position of the wheels on which the bands circulate, the direction of the bands being slightly oblique to the lengthways of the cloth. The endless straps are so fitted into grooves or troughs, that they are firmly retained to move straight forwards in their oblique direction; and the direction of the obliquity is such, that the

bands are nearest together at that end where their pins take hold of the lifts of the cloth; but as the bands move forwards with the cloth, they recede from each other, and extend the cloth in breadth in consequence of their obliquity, which may be increased or diminished as is found necessary. The actual width between the two bands can also be regulated according to the width of the piece of cloth.

It is not usual to crop the lifts of the cloth, and indeed as the lifts are usually of thicker substance than the other parts of the cloth, they would bear up the fixed blade too high from the cloth to cut the nap quite close.

For this reason, the bed or support on which the cloth is cut is so constructed, that it can be adapted in length to the breadth of the piece of cloth between the lifts, in order that the cloth only may be supported or borne up to the edge of the fixed blade; whilst the lifts, being depressed or borne down below the level of the bed, (by thin slips of metal called guards,) will escape the action of cropping, and thereby remain with the long wool upon their surfaces. The bed by which the cloth is borne whilst it is cut is only a narrow ridge of metal, over which it passes, so as to be bent with a sudden curvature, and in this way, the nap can be cut more close and even than upon a flat bed or soft cushion. The operation of cutting is facilitated by a row of pieces of metal screwed to a strong bar, to form a straight edge, very similar to the cutting edge of the fixed blade, but thin and elastic; this edge is placed close to the elevated ridge of the bed, and presses the cloth gently down upon the bed immediately before it comes to the edge of the fixed blade, against which the nap is to be cut off; this elastic edge being placed on one side of the ridge, and the cutting edge of the lower blade on the other side, the cloth is only exposed for a very narrow space just where it comes to the cutting edge. By this means, the cloth can with safety be brought nearer to a level with the upper surface of the fixed blade, so as to shear it closer than could otherwise be done without endangering the cloth.

The ends of the ridge part of the bed are composed of a number of narrow plates of metal, accurately fitted together, and placed side by side in a mortise made in the end of the solid bed; their upper ends project out of the mortise so as to line with the elevated ridge, and form a continuation thereof; but there is a sliding piece in the bottom of the mortise on which they all bear, and the point of it is of a wedge form. By removing this wedge, any number of the moveable pieces may be let down, so as to diminish the length of the elevated part of the bed at pleasure, according to the breadth of the cloth. The whole of this machine is very well contrived to effect the desired object; it will be found fully described with drawings in the *Repertory of Arts*, vol. xxix. p. 65.

Frizing is an operation sometimes used in the finishing of woollen cloth: it consists in rolling up and entangling the fibres, which form the nap on the surface of the cloth into small knots or burs, which cover near the whole surface, so that the cloth appears covered with small grains, which almost touch each other.

This operation is of no utility to the cloth, and it is difficult to say for what reason it was ever practised at all. The French first introduced it, and it was so much the fashion many years ago, that no other cloth was thought comparable in beauty. At present it is but little used, except for foreign markets, where our cloth meets the French cloth, which is still prepared in this manner, but generally on the back-side of the cloth only.

The frizing is done by a simple machine, in which the cloth is drawn across a narrow table by means of rollers,

to give it a very slow progressive motion. The table is covered with a coarse strong cloth, and over the table is placed a heavy plank of wood, of the same size as the table. The lower side of this plank, which bears upon the cloth, is covered with an artificial stone, composed of coarse sand, which is stuck together into a solid mass by glue or other cement, and a small but rapid reciprocating motion is given to the plank by means of two cranks of very small radius. These cranks are formed at the tops of two vertical spindles, the upper ends of which are fitted in sockets at the ends of the fixed table, and the ends which project up a few inches above the surface of the table are received into sockets formed in each end of the moveable plank. The projecting parts of the spindles are not in straight lines with those parts which are fitted in the fixed collars at the ends of the table, but are slightly cranked; hence, if the spindles are turned round, they must communicate motion to the plank, and slide it over the cloth backwards and forwards; or rather they move it with a circular motion, causing every point and grain of sand cemented to the plank to describe a small circle upon the cloth. It is this action which gathers together the fibres of the nap, and entangles them into knots or grains, as before mentioned.

To put the two spindles in motion, each one has a trundle or lantern fixed on the middle part of it, and the lower end is received in a stationary socket. These lanterns are turned round by the teeth of two face-wheels, fixed upon an horizontal axis, which lies beneath the machine. By this means, both the spindles and cranks are turned round at the same time, and with a very rapid motion. The rollers which draw the cloth forwards are turned round slowly by a communication of wheel-work, and draw the piece of cloth through the machine, that is, across the frizing-table, so that every part is in turn subjected to the action of the sand cemented to the plank. The nap must be left long for that cloth which is intended to be frized, and the operation is repeated twice or three times. See some further particulars in our article *FRIZING*, vol. xv.

Brushing.—After being shorn for the last time, the cloth is brushed all over, to remove the loose cuttings. This operation is now commonly performed by a machine which has two horizontal drums, or cylinders, covered with hair-brushes on the circumference. The piece of cloth is conducted over a system of rollers to extend it and draw it slowly forwards: it is conducted over one of the brushing-cylinders, and under the other; and as they are kept in rapid motion by the machine, they brush over both sides of the cloth at the same time, and lay all the fibres one way.

Pressing.—This is the last finish to the cloth, and gives it a smooth and even surface. The piece of cloth is folded backwards and forwards at every yard, so as to form a pack on the board of a screw-press; and between every fold sheets of glazed paper are placed, so that no part of the surfaces of the cloth can come in contact; also at every twenty yards three hot iron plates are put in between the folds, the plates being laid side by side, so that they occupy the whole surface of the folds; and thin iron plates, which are not heated, are also put above and below the hot plates to moderate the heat. When the pack of cloth is properly folded, and the press contains a proper quantity, the screw is forced down to give a very severe pressure to the pack. The cloth remains in the press until the plates are quite cold; it is then taken out and folded again, so that the creases of the former folds will come opposite to the surfaces of the paper, in order to be pressed with other hot plates.

The heat tends to soften the fibres of the wool, and the pressure

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pressure against the glazed paper, whilst they are so softened, lays all the fibres flat and smooth, so that the cloth has a very glossy appearance, and feels smooth, like satin; but this high finish to the cloth is very objectionable, because the slightest shower of rain will take it away, and when the drops of rain only wet it in parts, the cloth will become spotted and disfigured. For this reason, in pressing superfine cloth, the plates are very slightly warmed, and the cloth has but little gloss given to it. The glazed paper is a thick kind of cartridge, which is prepared by glazing or rubbing it very forcibly with a flint, as it lies upon a hard metal table. This operation is done by a water-mill.

For coarser cloths, some manufacturers gloss them with a large hot iron: it is a hollow box, into which a red-hot heater is introduced. The cloth is spread out upon a large flat table, and extended by hooks. The iron box is suspended by a tackle from the ceiling, so that it can be hoisted over to the middle of the table, and then two men work it backwards and forwards over the whole surface of the cloth, by means of two long poles or handles, which are jointed to it at one end.

The cloth is now finished, and is packed up in bales of twenty or twenty-five pieces, in order to be transported. The bale is first inclosed in paper, and then in canvas, and closely compressed by the screw-press. Some manufacturers use the hydrostatic presses for this purpose.

In considering the processes of the woollen manufacture, as they were practised forty or fifty years ago, and comparing them with the present practices, we find great changes and improvements, but they are by no means carried to so great an extent as in the cotton manufacture. This is owing in a great degree to the circumstance that the manufacture of woollen cloth was rendered very perfect, as far as the goodness and beauty of the cloth was concerned, long before the improved system was begun; and there were great numbers of experienced and able workmen trained up for each process, who by habit and dexterity performed their work as well as it could be done by machinery. The reduction of labour, or the substitution of ordinary hands for experienced workmen, was in this case all that machinery of the most perfect kind could effect; both these were advantages to the public and the manufacturer, but were so directly opposite to the inclination and interest of the able workmen, that we find they have made greater and more effectual opposition to the introduction of improvements in the woollen than in any other of our great manufactures.

At various periods attempts have been made by the workmen to suppress machinery, and many mills have been destroyed. In July 1802, considerable riots took place in Wiltshire and Somersetshire, in consequence of an attempt to set up the machines called gig-mills. It was contended that this was the same machine which was prohibited by an ancient statute of Edward VI. The disputes ran so high, that the attention of parliament was called to the subject of the laws then existing for the regulation of the woollen manufacture, and a committee was appointed to investigate the policy of encouraging or regulating machinery. In consequence, all the prohibitions of machinery were suspended. The report of this committee contains the following remarks, some of which are applicable to other manufactures as well as the woollen.

The introduction of the gig-mill and other machines was opposed from an idea that it would throw a considerable number of hands out of work; and it was contended, that it was highly injurious to the quality and texture of the cloth. With respect to the actual effects of the gig-mill and shearing-frame on the cloth, the committee report that deci-

five evidence has been adduced before them by merchants and manufacturers of the greatest credit and experience, to prove that these machines, especially the gig-mill, when carefully employed, finish the cloth in the most perfect manner, and that manufacturers residing in parts of the country where the gig-mill is not used, frequently send their cloths to a distance to be dressed by it.

It also appeared in evidence, that alarms similar to the present had existed among workmen at the introduction of several of the machines which are now in general use. Such alarms have gradually subsided as prejudice died away; and the machines are now fully established, without, as it appears, impairing the comforts or lessening the numbers of workmen. The committee remark with much satisfaction, that in many instances in which it was apprehended that the introduction of particular machines would throw such a number of people out of employment as to occasion great distress, the result has been very different; for besides the occupations which the attendance on such machines has given rise to, a fresh demand for labour to an immense extent has arisen out of the increased sale of the article, in consequence of the cheapness and superior quality of the manufacture.

They approve the system of patents, by which the inventor of any new machine secures to himself the exclusive benefits of his discovery for fourteen years; and only, at the end of that term, they are thrown open to the public; this provides in most cases against the too sudden and general establishment of any invention, by which a number of workmen might at once be thrown out of employment.

They next observe, that if the principles on which the use of these particular machines is objected to were once admitted, it would be impossible to define the limits or to foresee the extent of their applications. If the parliament had acted on such principles fifty years ago, the woollen manufacture could never have attained to near its present extent. The rapid and prodigious increase of late years in all the manufactures and commerce of this country is universally known, as well as the effects of that increase on our revenue and national strength. In considering the immediate causes of that augmentation, it appears to the committee, that it is principally to be ascribed, under the favour of Providence, to the general spirit of enterprize and industry among a free and enlightened people, left to the unrestrained exercise of their talents in the employment of a vast capital, pushing to the utmost the principle of the division of labour, calling in all the resources of scientific research and mechanical ingenuity, and, finally, availing themselves of all the benefits to be derived from visiting foreign countries, not only for forming new and confirming old commercial connections, but for obtaining a personal knowledge of the wants, the taste, the habits, the discoveries and improvements, the productions and fabrics, of other civilized nations. Thus bringing home facts and suggestions, perfecting our existing manufactures, and adding new ones to our domestic stock; opening, at the same time, new markets for the product of our manufacturing and commercial industry, and qualifying ourselves for supplying them.

The committee declare it to be their opinion, that by these means alone, and above all by the effect of machinery in improving the quality and cheapening the fabrication of our various articles of export, notwithstanding a continually accumulating weight of taxes, and with all the necessities and comforts of life gradually increasing in price, (the effects of which on the wages of labour could not but be very considerable,) our commerce and manufactures have also been increasing in such a degree as to surpass the most sanguine calculations of the ablest political writers who have speculated

lated on the improvements of a future age. The exports of woollen goods at the time of this report, (1807,) amounted to six millions of pounds official, or nine millions of real value.

It appeared also to be an important consideration, of which we should never lose sight, that we are at this day surrounded by powerful and civilized nations, who are intent on cultivating their manufactures and pushing their commerce; and who are more eager to become our competitors in trade, from having witnessed the astonishing effect of our commercial prosperity. The attempts which have been made to carry our machines and implements over to foreign countries, and to tempt our artificers to settle in those countries, evince the importance of machinery, under the directions of men of approved skill, in constructing and using them. It is needless to remark how much these attempts would be favoured by our throwing any obstructions in the way of enterprise and ingenuity, and the free application of capital in this country; for any machines which should be prohibited here would infallibly find their way into foreign nations in a very short time.

Among the attempts to improve the woollen manufacture, we must not omit to notice the invention of Mr. Joseph Booth, for fabricating woollen cloth without spinning or weaving. This was effected by felting wool into a web by the aid of machinery, which operated mechanically upon a tissue of carded wool, to entangle and interlace the fabrics together. The inventor took a patent for this in 1793 or 1794, but before the time for the enrolment of the specification of his process, he obtained an act of parliament, the preamble of which states, that on account of the great importance of the art, and the danger of its being carried abroad to the injury of the staple manufacture of the kingdom, parliament had determined to keep the specification sealed; hence we are not able to give the details of this machinery.

We find these expectations have not been realized; for, although the process has been repeatedly tried on a large scale and in the most complete manner, it has been abandoned. Three large mills were established at Taunton and near Salisbury, by experienced woollen manufacturers of the west of England; another mill was converted to the purpose at Lewisham, in Kent; and the last mill was erected at Merton, in Surrey, the property of James Perry, esq. We learn from this gentleman, that he was able to manufacture cloth of a fine surface, and of a very even and regular substance, but it was rather deficient in strength, for want of the threads which form the substance of common cloth; and in respect to wear it was less durable than common cloth, as it did not long withstand brushing; otherwise the expence of the process, which was not one-fourth of the common process, would have brought it into general wear.

There has been a great number of other projects and patents for the improvement of different branches of the woollen manufacture; but as we have already noticed most of those which have come into use, we shall not enumerate any more of the unsuccessful attempts.

The machinery for manufacturing long combing-wool is described in the article WORSTED.

WOOLLEN *Nets*, in *Gardening*, a kind of nets employed as a protection in the setting of the fruit of different sorts of tender trees. See WOODEN *Frames*, &c.

WOOLLEN *Rags*, in *Agriculture*. See WOOLLEN RAGS.

WOOLLENS, *Bleaching of*. See BLEACHING.

WOOLLEY-WOOLLEY, in *Geography*, a town of Africa, in the kingdom of Yani.

WOOLLI, a kingdom of Africa, bounded by Walli

on the W., by the Gambia on the S., by the small river Walli on the N.W., by Bondou on the N.E., and on the E. by the Simbani wildernesses. The country every where rises into gentle acclivities, which are generally covered with extensive woods, and the towns are situated in the intermediate valleys. Each town is surrounded by a tract of cultivated land, the produce of which is thought to be sufficient for supplying the wants of the inhabitants; the soil appeared to Mr. Park to be every where fertile, except near the tops of the ridges, where the red iron-stone and stunted shrubs sufficiently marked the boundaries between fertility and barrenness. The chief productions are, cotton, tobacco, and esculent vegetables; all which are raised in the valleys, the rising grounds being appropriated to different sorts of corn. The capital is Madina, or Medina, signifying in the Arabic *city*. (See MEDINA.) The inhabitants are Mandingoes, (see MANDING,) who, like most of the Mandingo nations, are divided into two great sects, the Mahometans, who are called Bushreens, and the Pagans, who are denominated indiscriminately Kafirs, *i. e.* unbelievers, and Sonakies, *i. e.* men who drink strong liquors. The latter are the most numerous, and the government of the country is vested in them; for though the Bushreens are consulted in all matters of importance, they are not allowed to take any share in the executive government, which rests solely in the Manfa, or sovereign, and great officers of the state. Of these, the first in point of rank is the presumptive heir of the crown, called the Farbonna; and next to him are the Alkaidis, or provincial governors, who are more frequently styled Keamos. Then follow the two grand divisions of freemen and slaves, the Slatees being considered as the principal of the former; but in all classes great respect is paid to the authority of aged men. Park's Travels, vol. i.

WOOLLIMA, BA, a river of Africa, called also *Wonda*; which see.

WOOLLY-PASTINUM, in *Natural History*, a name given by the East Indians to a species of native red arsenic, or orpiment, found in that part of the world.

It is of a paler colour than the red orpiment of Germany.

WOOLMAN, JOHN, in *Biography*, a minister of the society of Friends in North America, chiefly remarkable as an early and faithful advocate of the rights of the enslaved Africans, was born at Northampton, in Burlington county, West New-Jersey, in the year 1720. From some memoirs of his life left by himself, it appears that he had strong impressions of religion in childhood, which being seconded by the care and admonition of pious parents, he arrived at manhood, after a struggle of some years with youthful levities, with a decidedly religious character. An incident which befel him when a child, and which he records as a proof of the early influence of divine grace on the mind, may be mentioned here, as connected also with his future character, and with the first development of those tender sympathies of the heart which, under the guidance of Christian principle, fitted him so eminently to espouse the cause of the oppressed negroes. Going on an errand to a neighbour's, he observed that a robin quitted her nest at his approach, and flew about in alarm for her young ones. He stood and threw stones at her, till being struck, she fell down dead. "At first," he says, "I was pleased with the exploit, but after a few minutes was seized with horror. I beheld her lying dead, and thought those young ones, for which she had been so careful, must now perish for want of their dam to nourish them: and after some painful considerations on the subject, I climbed up the tree, took all the young birds, and killed them, supposing that better than to leave them to pine

WOOLMAN.

away, and perish miserably. I then went on my errand, but for some hours could think of little else but the cruelties I had committed, and was much troubled. Thus He, whose tender mercies are over all his works, hath placed a principle in the human mind, which incites to exercise goodness towards every living creature: and this being singly attended to, people become tender-hearted and sympathizing, but being frequently and totally rejected, the mind becomes shut up in a contrary disposition." Of his opinions at one-and-twenty he writes thus: "I was early convinced in mind that true religion consisted in an inward life, wherein the heart doth love and reverence God the Creator, and learns to exercise true justice and goodness, not only toward all men, but also toward the brute creatures. I found no narrowness respecting sects and opinions, but believed that sincere, upright-hearted people in every society, who truly loved God, were accepted of him."

The right of every individual, of whatever colour, who has not offended against society, to liberty and the common gifts of providence, was consequently at this time an article of John Woolman's *religious creed*: and we shall see that he soon brought himself to act in consistency with his faith. The first occasion of trial occurred while he was yet in servitude; for he had engaged himself as clerk and assistant to a shop-keeper at a place called Mount-Holly. His employer parted with a negress, and desired Woolman to write out a bill of sale for her. "The thing," says he, "was sudden, and although the thought of writing an instrument of slavery for one of my fellow-creatures felt uneasy, yet I remembered that I was hired by the year, that it was my master who directed me to do it, and that it was an elderly man, a member of our society, who bought her. So through weakness I gave way and wrote; but at the execution of it I was so afflicted in my mind, that I said before my master and the friends, that I believed slave-keeping to be a practice 'inconsistent with the Christian religion.' This in some degree abated my uneasiness; yet as often as I reflected seriously upon it, I thought I should have been clearer if I had desired to be excused from it, 'as a thing against my conscience;' for such it was." Accordingly, on the next occasion he took this second step. "A young man of our society," he proceeds, "spoke to me to write a conveyance of a slave to him, he having lately taken a negro into his house. I told him I was not easy to write it: for though many of our meeting and in other places kept slaves, I still believed the practice was not right." Other cases followed, in which being employed (as it appears for an adequate fee) to write the will of a neighbour or a friend, he uniformly refused to be accessory to their bequeathing as property the persons of his fellow-men. "Deep-rooted customs," he observes, "though wrong, are not easily altered; but it is the duty of all to be 'firm in that' which they certainly know is 'right for them.' A charitable benevolent man, well acquainted with a negro, may, I believe, under some circumstances, keep him in his family as a servant for no other motive than the negro's good. But man, as man, knows not what shall be after him, nor hath assurance that his children will attain to that perfection in wisdom and goodness necessary rightly to exercise such power," viz. as that of the owner over his slave. As the first-fruits of this firmness, and which no doubt were highly grateful, he relates instances in which his refusal, and the reasons he gave for it, procured the freedom in lieu of the transmission of the slaves in question.

Having been acknowledged by his friends in the capacity of a minister of the gospel, he made some journeys in the exercise of his gift, which served to give him a further insight

into the condition of the negroes on that continent, and further excited his attention to the then practice of the society of friends, in common with others, of holding them in bondage, and even of buying them. In the year 1746 he passed through Virginia, Maryland, and Carolina, of which he writes as follows: "Two things were remarkable to me in this journey: first, in regard to my entertainment, when I ate, drank, and lodged at free-cost with people who lived in ease on the hard labour of their slaves, I felt uneasy; and as my mind was inward to the Lord, I found, from place to place, this uneasiness return upon me at times through the whole visit. Where the masters bore a good share of the burthen, and lived frugally, so that their servants were well provided for, and their labour moderate, I felt more easy; but where they lived in a costly way, and laid heavy burthens on their slaves, my exercise (trouble of mind) was often great, and I frequently had conversation with them in private concerning it. Secondly, this trade of importing slaves from their native country being much encouraged among them, and the white people and their children to generally living without much labour, was frequently the subject of my serious thoughts. And I saw in these southern provinces so many vices and corruptions, increased by this trade and this way of life, that it appeared to me 'as a gloom over the land;' and though now many willingly run into it, yet in future the consequence will be grievous to posterity. I express it as it hath appeared to me, not once nor twice, but as a matter fixed on my mind."

It is probable that the inhabitants of the southern provinces of North America now see pretty clearly that their negro population, without consummate prudence, as well as great kindness in the management of them, are likely one day to justify these anticipations.

On his return from the above-mentioned journey, he committed to paper his sentiments on slave-keeping, and after the MS. had lain long by him, it was published, with the approbation and at the expence of his friends, who began (in Pennsylvania and the Jerseys at least) to be more generally influenced by the humane and Christian views of Woolman, Benezet, and others on this subject. It was entitled "Some Considerations on the keeping of Negroes;" and in 1762 was followed by a "Second Part," the expence of which he preferred to take upon himself, for a reason which evinces his strict regard to justice. He considered that many, who did not yet see the evil of the practice, nor approve of his writings against it, were contributors to the general fund of the society, out of which the cause was proposed to be defrayed.

Some other reflections, written in 1757, while he was on a journey among slave-holders, and recorded in his "Memoir," are forcibly descriptive of his views and feelings.

The necessary brevity of this article will permit only a general account of John Woolman's labours in the cause of humanity. From private conferences with the holders of slaves, he proceeded to public addresses to the society in their meetings for discipline: and when at length the principle of the unlawfulness to Christians of this degrading practice had been generally recognized among them, he united other members with himself in paying visits to such of the society, within his sphere of action, as required the stimulus of remonstrances to induce them to comply with the sense of their brethren on this subject. These proceedings were prosecuted through several journeys; in which at one time the religious welfare in a more general sense, at another the right conduct in this particular of his fellow-members, engaged his attention. He did not live to see the completion of his wish as it related to the society; for it was not

till the year 1787 that the last slave disappeared from among them. But the near approach of this conflagration was witnessed by his coadjutor, Anthony Benezet, who died in 1784, whose fame has spread wider than Woolman's, because his opportunities were more extensive, who lived for the cause throughout Europe, and carried its successful plea from the narrow limits of the society of Friends into the world at large. Of this excellent man, whose biography escaped the early part of this work, it may not be too late here to record in brief,—that he was born at St. Quintin, in Picardy, of a respectable family, in 1713; that he was carried by his father, who fled from the persecutions which fell upon the Huguenots, to London, and there formed for mercantile pursuits; that upon removing to Philadelphia with his family in 1731, having now entered into the society of Friends, he devoted his life, upon principle, first to the education of youth in useful knowledge and the Christian faith, and ultimately to the noblest toils of humanity. But to return to our present subject: in the year 1772, John Woolman, believing it his duty to pay a religious visit to the friends in England, embarked for that purpose at Chester, on the Delaware, and arrived at London in time to attend their yearly meeting. After it he travelled, exercising his ministry among his friends, through several counties, as far as York. Here, at a large quarterly meeting, he once more pleaded for the negroes, endeavouring, and probably with effect, to engage the support of those present to the cause of humanity: soon after which he was seized with the small-pox. During a severe struggle with this disease, he manifested great patience and humility, with a firm faith in the Redeemer: and nature sinking in the conflict, he expired in peace in his fifty-second year.

As a preacher, we hear not of his eloquence nor of his learning, except, says one of the respectable friends who has favoured us with the documents of this article, “in heart-knowledge, and in the school of Christ;” but in life, he was a bright example of the integrity, meekness, charity, and beneficence which in that school alone are to be acquired; and his memory for his works’ sake is blessed. Memoir of John Woolman, chiefly extracted from a Journal of his Life and Writings, London, 1815.

WOOLPER’S CREEK, in *Geography*, a river of Kentucky, which runs into the Ohio, N. lat. 38° 53'. W. long. 85° 7'.

WOOLPIT, a village of England, in the county of Suffolk; 8 miles E. of Bury St. Edmunds.

WOOLSTANTON, a village of England, in Staffordshire; 2 miles N. of Newcastle-under-Line.

WOOL-STAPLE, denotes a city or town where wool used to be sold. See STAPLE.

WOOLSTED. See WORSTED.

WOOLSTON, THOMAS, in *Biography*, an English divine, was born in 1669 at Northampton, and admitted in 1685 of Sidney college, Cambridge, where he was distinguished by his diligence and regularity. He was elected fellow of his college, took orders, preached with approbation, and was esteemed for his learning and piety. In his exercises for the degree of B.D. he maintained “the exact fitness of the time in which Christ was manifested in the flesh,” in a discourse which was well received. But his temper being naturally enthusiastic, and perusing the works of Origen, he indulged a great fondness for allegorical interpretations of scripture, which afterwards led him into a variety of singular and extravagant opinions. He began in 1705 with “The old Apology for the Truth of the Christian Religion against the Jews and Gentiles revived,” maintaining that all the actions of Moses were

typical of Christ, and of his church; and the book was issued from the university press. Woolston remained in college till the year 1720, when he went to London, and published a Latin dissertation concerning the supposed epistle of Pontius Pilate to Tiberius, relative to Jesus Christ. In the same year he also published two Latin epistles, addressed to Whitty, Waterland, Whiston, and others: “Circa Fidem vere Orthodoxam et Scripturarum Interpretationem,” defending Origen’s allegorical interpretation of scripture. His deviation from the established faith was more apparent in his inquiry, “Whether the people called Quakers do not the nearest of any other sect in religion resemble the primitive Christians in principles and practice?” Blending sarcasm with argument, he now seemed to indulge a spirit of animosity against the clergy. Declining at the same time to reside at college, he was deprived of his fellowship in 1721. In his “Four Free Gifts to the Clergy,” he denominated them “hireling priests,” and “ministers of the letter.” Although he might be suspected, he was not yet chargeable with historical incredulity; for in 1726 he published “A Defence of the Miracle of the Thundering Legion against Mr. Moyle.” At length he engaged in the controversy between Anthony Collins and his opponents, and published “The Moderator between an Infidel and an Apostate,” and “Two Supplements,” in which he not only contended for mystical interpretations of the miracles of Christ, but maintained that they were never actually wrought. Considered as an avowed enemy to the Christian religion, a prosecution was instituted against him by the attorney-general, but stayed by the interposition of Whiston, and some other advocates of toleration. Notwithstanding this lenity, he proceeded in publishing “Six Discourses on the Miracles,” and two “Defences of the Discourses,” in which, blending ridicule and buffoonery with argument, he maintained his offensive opinions. This pertinacity and rudeness prejudiced believers in the divine mission of Christ against him; replies issued from the press; but as he again became amenable to the law, he was tried at Guildhall before lord chief justice Raymond, when, after many arguments for and against him, he was found guilty, and sentenced to a year’s imprisonment, and a fine of 100*l*. Unable to pay his fine, he resided within the rules of the King’s Bench, and subsisted by an annual allowance granted to him by his brother, and the contributions of some learned and liberal friends, who vindicated his intentions, whilst they disapproved his enthusiasm and fanaticism. Among these were some, and particularly Dr. S. Clarke, who condemned every species or semblance of religious persecution, and who endeavoured to procure his release; but they could not prevail upon him to stipulate that he would not persevere in publishing his peculiar opinions. But death gave him that release, which his friends could not obtain for him; as he was carried off by an epidemic disease, within four days after his seizure, in January 1732–3. Not long before he expired, he said, “This is a struggle which all men must go through, and which I bear, not only patiently, but willingly.” His moral character is said to have been unimpeachable, and his head was thought to have been more disordered than his heart. Biog. Brit.

WOOLWICH, in *Geography*, a market-town and parish in the hundred of Blackheath, lath of Sutton-at-Hone, and county of Kent, England, is situated on the S. bank of the Thames, 8 miles E. from London. The etymology of Woolwich, a name very variously written at different periods, is uncertain: according to Hasted, in his “History of Kent,” one of the ancient names, Hulviz, signified the “dwelling on the creek.” The parish comprehends about

about 700 acres, of which above one-half, however, lie on the opposite bank of the Thames, in the county of Essex, and consists of marsh-land, on which stood formerly a few houses, and a chapel of ease. The manor of Woolwich is subordinate to the royal manor of Eltham. The town consists chiefly of one narrow irregular street, confined between the rising land and the river; but several other streets, rows, and lanes, are connected with it. The church, a spacious brick building, consists of a nave, chancel, and aisles. It is situated on an eminence overlooking the town and the dock-yard, and was completed in 1740. Besides this building, Woolwich contains several different dissenting meeting-houses. The principal charitable establishments are an alms-house and two schools. Woolwich was originally but a small place, inhabited by fishermen, and is indebted for its importance to the establishment of a royal dock there in the reign of Henry VIII. Since that time, it has gradually arrived at its present augmented state; but particularly since the establishment there of the head-quarters of the artillery and the royal arsenal; by which means the population within the last hundred years has increased six-fold. The precise period of the establishment of the dock-yard is uncertain: it appears, however, that the *Harry Grace de Dieu*, of 1000 tons, was built there in 1512. This celebrated ship is stated to have been in length 128 feet, and in breadth 48 feet: she had three flush decks, a fore-castle, half-deck, quarter-deck, and round-house, and carried 176 pieces of ordnance: she had eleven anchors, the largest of which weighed 440 lbs. In its present enlarged state, the yard extends about five furlongs along the river by one furlong in breadth. It comprehends two dry docks, several slips, three mast-ponds, a smith's-shop and forges for making anchors, a model-loft, store-houses, sheds, dwellings for various officers, and all other requisite buildings. The whole is under the immediate inspection of the navy board, but conducted by several resident officers. The number of artificers and labourers employed during peace is about 1500; but in war-time it rises towards 4000. Between the dock-yard and the royal arsenal, formerly called the Warren, is the rope-walk, 400 yards in length. The military and civil branches of the office of ordnance have been established at Woolwich since the accession of George I. In the time of peace, this arsenal is the great repository of naval ordnance, where the guns of most of the ships of war are laid up there in order. The repository contains also an extensive collection of military machines and models. The arsenal, comprehending about sixty acres of ground, contains, with other buildings, the foundery, and the late military academy, which was erected by sir John Vanbrugh. The foundery is provided with several furnaces, the largest of which will melt about seventeen tons of metal at once. It contains also machinery for boring brass cannon, as they are improperly called, for they are composed of copper and tin instead of zinc. In the adjoining laboratory, bombs, carcasses, cartridges, &c. for the navy and army, are prepared. The number of persons employed in the arsenal during war is about 300, exclusive of the convicts belonging to the hulks or prison-ships lying in the river. The military academy, although founded in 1719, was not finally arranged till 1741, and has been fortunate in possessing, in the mathematical chairs, the eminent professors Derham, Simpson, and Hutton. Besides the mathematical professors, here are masters in chemistry, fortification, arithmetic, French, drawing, fencing, &c. The number of pupils or cadets, destined for the two corps of artillery and royal engineers, has been lately about 300. To provide necessary accommodation, with offices, &c. a new edifice was con-

structed and opened in 1806, about a mile S. from the town, on the upper part of the common. It is built in the castellated form, from designs by Mr. James Wyatt. The principal front facing the N. extends above 200 yards. The expense of the structure is estimated at not less than 150,000*l.* The establishment is appropriated to the senior class of the cadets, the junior being for the present fixed at Black-Water in Hampshire. Between this new academy and the town are extensive ranges of barracks, &c. for the royal artillery, horse and foot, which has increased during the late war beyond all former example.

The population of Woolwich, in the return of 1800, was stated at 9826, exclusive of the military, inhabiting 1362 houses; but the number was probably under-rated; for in the return of 1811, the inhabitants are stated to be 17,054, and the houses 2487. Woolwich-common unites with the extensive plain of Blackheath on the S., which gives name to the hundred. At its eastern extremity rises Shooter's-hill, which commands extensive and interesting prospects in all directions. The view from it of London, the Thames, and the shipping, is peculiarly impressive. Over this hill passed the great Roman road from the E. coast of Kent, through *Durovernum*, now Canterbury, and *Durobriva*, Rochester, to London. Its course is nearly pursued by the present road from Shooter's-hill, for eight miles, to a place beyond Dartford.—*Beauties of England, Kent*, by E. W. Brayley, 8vo. 1806.

WOOLWICH, a township of New Jersey, in the county of Gloucester, with 3063 inhabitants; 10 miles S.E. of Philadelphia.—Also, a township of the province of Maine, containing 1050 inhabitants, on the E. side of the Kennebec; 16 miles N.E. of Brunswick.

WOOL-WINDERS are persons employed in winding up fleeces or wool into bundles to be packed, and sold by weight. Persons winding and selling deceitful wool, shall forfeit for every fleece 6*d.* These are sworn to do it truly between the owner and the merchant. 8 Hen. VI. cap. 22. 23 Hen. VIII. cap. 17.

WOORLA, in *Geography*, a town of Hindoostan, in Visapour; 16 miles N. of Merritch.

WOOTAMALLY, a town of Hindoostan, in Madura; 15 miles S.W. of Coilpetta.

WOOTTON, JOHN, in *Biography*, an eminent, though not very able, painter of landscape and animals, who flourished in England about 1720. He was a pupil of John Wyck, and was much employed in the portraits of horses and dogs, and in painting the sports of the field, particularly fox-hunting; upon which subject there are seven pictures of his engraved by Canot. Once at least he attempted (but he did not frequently repeat the attempt) to portray a battle, and his subject was that of Culloden at the time of the rout of the rebel army. It has been engraved by Baron, though it is but an indifferent performance. He died in 1765. He had been successful in the pursuit of his art, for he was enabled by its proceeds to build a house in Cavendish-square, where he lived, and had painted it with taste, according to Walpole, who praises his works ridiculously. His pieces, he says, were high, forty guineas for a single horse the size of life, and twenty if smaller.

WOOTTON-BASSET, in *Geography*, a borough and market-town of Wiltshire, England, is situated near the northern extremity of the county, at the distance of 36 miles N. by W. from Salisbury, and 89 miles W. from London. It consists chiefly of one principal street, about half a mile in length. The houses are mostly constructed of brick with thatched roofs. Two representatives have been regularly deputed from this town to serve in parliament

ment since the 25th of the reign of Henry VI. They are elected by the inhabitant householders legally settled there, and paying scot and lot. The corporation is composed of a mayor, two aldermen, and twelve burgesses. The market-day is Tuesday, weekly; and there are also six fairs annually. In the centre of the town are a market-house and shambles; and near this is the town-hall, in which a machine, called a "cucking or ducking-stool," formerly used for the punishment of female scolds, was lately preserved. The church is an old building dedicated to St. Bartholomew, but it is not remarkable for beauty of architecture, nor does it contain any monument or inscription worthy of notice.

According to the population returns of 1811, the borough and parish contained 321 houses, and 1390 inhabitants, who formerly carried on a considerable trade in broad-cloths; but there is now no staple manufactory of any sort, though some attempts have been lately made to introduce the business of rope-making and sack-making. In this parish are two free-schools and a Sunday school. The former were founded and endowed by the earl of Clarendon, one of them for twelve boys, and the other for twelve girls.

At the time of the Conquest, this place was called simply 'Wodeton.' It was then the property of Milo Crispin; but in less than a century afterwards it was possessed by the Bassetts of Wycomb, a branch of the noble family of the Bassetts of Drayton. The present proprietor is the earl of Clarendon. The ancient manor-house, which stands on the summit of a considerable eminence, is now converted into a farm-house, whence the eye surveys a very extensive prospect into Somersetshire, Gloucestershire, &c. A variety of curious conical stones, resembling small fir-apples, have been dug up in different spots around the town, imbedded in a sort of blue marly stone.

Liddiard-Tregooze, or Lydiard-Tregose, is a village and parish, situated at the distance of three miles north-east from Wootton-Basset. According to the population returns of 1811, the parish contains 95 houses, and 613 inhabitants.

The church, an ancient structure, is divided into a nave, two side aisles, and a chancel, with a square tower at the west end, surmounted by an open balustrade and angular pinnacles. The church contains several interesting monuments of the St. John family; also a very curious genealogical table with arms, &c.

Adjoining to the church is Liddiard-park, the seat of lord Bolingbroke. The attached grounds are extensive, and contain many large clumps of trees, among which are a great number of old oaks.—*Beauties of England and Wales, Wiltshire, by J. Britton, 1815.*

WOOTZ, in *Metallurgy*, a metal extracted from an ore of iron in the East Indies, the nature of which is not known at present in Europe. Wootz is highly esteemed by the natives of India, and applied to various purposes in the arts.

Dr. Scott gave the following account of its properties, in a letter to the president of Bombay:—"Wootz admits of a harder temper than any thing known in that part of India. It is employed for covering that part of gun-locks against which the flint strikes. It is used for cutting iron on a lathe, for cutting stones, and for chisels; also for making files and saws, and for every purpose where excessive hardness is necessary: it cannot, however, bear any thing beyond a slight red heat, which makes it work very tediously in the hands of the smith. It has a still greater inconvenience or defect, that of not being welded with iron or steel, to which, therefore, it is only joined by screws and

other contrivances." Dr. Scott observes farther, that when wootz is heated above a light red heat, part of the mass seems to run, and the whole is soft, as if it consisted of metals of different degrees of fusibility. The working with wootz is so difficult, that it is a separate art from that of forging iron. The magnetical power can only be imperfectly communicated to it. Specimens of wootz sent from India were examined by Dr. George Pearson, who states in the *Phil. Transf.* vol. xcvi., that they were in the form of round cakes, about five inches in diameter and one thick, each of which weighed more than two pounds. The cake had almost been cut through, so as to divide it into two nearly equal parts. It was externally of a dull black colour, the surface was smooth, the cut part was also smooth, and, excepting a few small holes, the texture appeared to be uniform. No indentation could be made in it by blows with a heavy hammer, nor was it broken by blows that might have broken a like piece of steel. Fire was elicited on collision with flint. It possessed the hardness of some kinds of crude iron, but did not effectually resist the file, like highly tempered steel, and many kinds of crude iron. It admitted a polish equal to the best steel. The wootz-filings were attracted by the magnet like common iron-filings. When broken, it exhibited the fracture and colour of a rather open-grained steel. It was tasteless and inodorous. Its specific gravity in different states, as given by Dr. Pearson, ranges from 7.2 to about 7.7, which is nearly the same as steel. From the properties of this substance, Dr. Pearson concludes, that wootz approaches nearer to the state of steel than raw iron, although it possesses some of the properties of this last substance. It is not to be referred to that kind of steel in which there is either an excess or deficiency of carbon, but it contains something besides carbon and iron, otherwise it would be common steel. The solution in nitrous and dilute sulphuric acid contained only oxyd of iron, and the residue of carbonaceous matter, as in common steel. Hence, says Dr. Pearson, it is obvious to suspect, that wootz contains oxygen, either equally united with every part of the mass, or united with a portion of iron to compose oxyd, which is diffused through the mass. To this circumstance, Dr. Pearson seems inclined to attribute the smaller quantity of hydrogen gas given out during solution, than is afforded by common steel, and to account for its partial fusibility and difficult malleability, and may be the reason of its taking a fine edge or polish. The oxyd is not perhaps equally diffused; hence the wootz is not quite uniform in its texture and hardness until it has been remelted. The proportion of oxygen in wootz, says Dr. Pearson, must, however, be very small, otherwise it would not possess so much strength, and break with so much difficulty. The oozing out of matter when fused is analogous to what appears on refining raw iron. Although no account is given by Dr. Scott of the process for making wootz, we may without much risk conclude, that it is made directly from the ore, and consequently that it has never been in the state of wrought iron, for the cake is evidently a mass which has been fused, and appears to have been cut almost quite through while white hot at the place where wootz is manufactured. The particular uses to which wootz may be applied are to be inferred from the preceding account of its properties and composition; and may be proved by an extensive trial of it in all the arts which require iron. See *Phil. Transf.* vol. xcvi.

WOPANKEN, in *Geography*, a town of Prussia, in the province of Bartenland; 2 miles E. of Bartenstein.

WOPELBACH, a river of Osnabruck, which runs into the Dalcke, 2 miles N. of Weidenbruck.

WORADA,

WORADA, a country of Africa, of an oval form, about 90 miles in circumference, S. of Konkadoo.

WORANY, a town of Lithuania; 28 miles S. of Troki.

WORBIS, or **STADT WORBIS**, a town of Westphalia, in the territory of Eichsfeld, on the Wipper; 8 miles S.S.E. of Duderstadt.

WORBIS, *Breiten*, a town of Westphalia, in the territory of Eichsfeld; 9 miles S.E. of Duderstadt.

WORBIS, *Kirch*, a town of Westphalia, in the territory of Eichsfeld; 8 miles S.S.E. of Duderstadt.

WORBITZ, a town of Bohemia, in the circle of Czaflau; 10 miles S. of Czaflau.

WORBITZ See, a lake of the Ucker Mark of Brandenburg, near Joachimthal; 28 miles N.N.E. of Berlin.

WORBSTADT, a town of France, in the department of Mont Tonnerre; 10 miles S.S.W. of Mentz.

WORCESTER, the capital city of a county of its own name, in the W. of England, situated in N. lat. $52^{\circ} 10'$, and W. long. $2^{\circ} 00'$; distant 26 miles N. from Gloucester, 27 S.W. from Birmingham, 30 E. by N. from Hereford, and 111 W.N.W. from London. The inhabitants in 1811 were, according to the returns made to parliament, 5953 males, and 7861 females, in all 13,814, and the houses 2527.

Historical Events.—Worcester is a place of high antiquity, as implied by the latter part of the name, indicating that the original town occupied the position of a Roman station: its proper name under those people, however, has not yet been ascertained. Camden indeed conceives it to be the *Branonium* of Antoninus' Itinerary, the same with the *Branogenium* of Ptolemy; but that town is placed by Horsley at Ludlow, more to the N.W., on the S. border of Shropshire. Nennius, who wrote in the beginning of the 7th century, points out Worcester by the British names *Caer-Guorangan* and *Caer-Guorcon*. By the Saxons it was called *Weogareceaster*, or *Wegeorna-ceaster*, from which came *Wigornia*, the Latin name still in use. In the Domesday-book it is called *Wirccestre*. The diocese of Worcester was founded by Ethelred, king of Mercia, about 680, the first bishop nominated being Tatfrith; but dying before consecration, the first who filled the episcopal chair was Bosel, a learned man from the celebrated monastery of St. Hilda, at Whitby in Yorkshire. St. Egwin, the third bishop, who was appointed in 693, was the founder of the abbey at Evesham. Mildred was nominated in 744. The 17th prelate was the famous St. Dunstan, who was appointed in 957. St. Wulfstan II., appointed in 1062, was the founder of the present cathedral. Adam de Orleton, bishop in 1327, is supposed to have prompted the murder of Edward II. by the equivocal answer he gave when consulted on the project: "*Edwardum occidere nolite timere bonum est.*" The 60th bishop, nominated to Worcester in 1521, was the celebrated Julius de Medicis, a cardinal, and afterwards pope Clement VII. His successor, Jerome de Ghinucci, also an Italian, was deprived at the Reformation, and, in 1535, was succeeded by Hugh Latimer, who suffered for his Protestant profession, under queen Mary, in 1555. John Prideaux, the 84th prelate, appointed in 1641, was dismissed during the interregnum, his bishopric sequestered, and himself allowed four shillings and sixpence *per week* for his maintenance. The eminent scholar Stillingfleet filled the see from 1689 to 1699. In 1717, the see was filled by John Hough. (See his biographical article.) The learned bishop Hurd, appointed in 1781, was succeeded in 1799 by the present prelate, bishop Cornwall. The revenues of the see

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were, in 1699, fixed at 1302*l.* 15*s.* 4½*d.*; but now supposed to exceed 3000*l.* The see has possessed one pope, four saints, seven high-treasurers of England, eleven archbishops, besides chancellors of the kingdom, and other great officers of the state. Few places, perhaps, have suffered more than Worcester by the intestine broils of the country, and by casual disasters. Ruined by the Danes about the year 894, it was rebuilt by Ethelred and Ethelfleda; but the inhabitants refusing to pay the tax called danegelt, the city was again laid waste by Hardicanute. Again restored, it suffered severely during the contest between king Stephen and the empress Maud, as well as by a fire, from which the walls of the cathedral alone were preserved. Taking the part of Lewis, the dauphin of France, against king John, the king's troops exercised every tyrannical severity on the inhabitants; the church was plundered, and a heavy sum exacted from the clergy. John was nevertheless interred in the cathedral in 1216. It was in Worcester that, previously to the battle of Evesham, young Edward raised the standard of loyalty for his father, Henry III. After the accession of Henry VII. several citizens were beheaded, and a fine of 500 marks was levied on the city. In 1642 Worcester witnessed the sanguinary contest which terminated so fatally for the affairs of Charles I. (See CHARLES.) In 1646, the city surrendered by capitulation to the parliament's army, having been the first city in England to declare for the crown, and the last which held out in its defence. In 1651 happened the second battle of Worcester under Charles II.; a battle which decided the destructive and vindictive controversy between the royalists and the parliamentary party, by which the latter obtained a complete ascendancy; and the king himself escaped with difficulty out of the country. To preserve the memory of this success, "the lord-general Cromwell, on the 18th of September 1651," says Leach, in his Diurnal, "with many officers of the army, was at Woollidge, at the launching of a gallant new frigate of the states, carrying three-score peeces of ordnance, and called her name Worcester."

Present State.—Worcester is distinguished among the provincial towns of England for its resemblance, in various respects, to the metropolis. It is described to be well built, well paved, and well lighted. It consists principally of one great street running from N. to S., and terminating at the cathedral; also thirteen other collateral streets, besides lanes of inferior dimensions. The circuit of the city exceeds three miles and a half. The Severn, bathing the western side, and carrying vessels of considerable burthen, is of great utility in facilitating the commerce to and from, as well as the requisite supplies of the city. On it, passage-boats sail up as far as Shrewsbury, and down to Gloucester and Bristol. The buildings now extend beyond the ancient limits, which may, however, still be traced; the old wall, according to a plan made before the civil wars, was in extent 11,650 paces; but this wall, after the last battle of Worcester, was almost wholly destroyed. The castle was erected by Urfo of Abitoth about 1088. The area, now called the College-green, was, in the Norman times, the outer ward of that castle, behind which to the S. was the inner ward, or fortrefs itself. A gaol for the retention of the prisoners of the county is all that now remains of the castle, on the spot where the kings of England formerly kept their court. A steep artificial mount, on which probably stood the keep of the fortrefs, is a prominent object; the surrounding ditch and rampart may also be easily traced.

Cathedral.—The original cathedral of Worcester was founded in 680; but in 969 its revenues were transferred

to the monastery of St. Mary, an establishment of the beginning of the eighth century. The church of this monastery being unsuitable to its novel application, another cathedral was erected and consecrated by St. Oswald, the bishop, in 983. Being ruined by Hardicanute in 1041, the foundation of a new cathedral was laid in 1084, by bishop Wulfstan II.; and in 1089 he finished it, together with the monastery, and called the same *Monasterium St. Marie in Cryptis*. The original plan of this church seems to have been a simple cross, the entrance being at the west end of the present choir, which occupies the place of the ancient nave. This ancient structure had probably a central or principal tower; as it is recorded that the *new* tower fell down in 1175, and two smaller ones were destroyed by a storm in 1222. The antiquity of this part of the edifice is particularly apparent from the crypt or undercroft, which extends under the choir and its aisles. This is a curious and interesting part of the fabric. Twice severely injured by fire, in 1113 and in 1202, the cathedral was re-consecrated in 1218, by bishop Silvester, in the presence of Henry III. and his court. Six years afterwards the foundation of an additional work, the present nave, was laid by bishop William de Bloys, in which is displayed the skill of the architect, in adapting the new parts to the former structure. The stone-vaulting of the edifice was begun by bishop Cobham in 1327, and the whole was finished in 1357. The beautiful central tower was constructed in 1374. Worcester cathedral is in the exterior extremely plain, and its attractions consist principally in the height, space, and the lightness of its architecture, to which the lofty pinnacles, rising from every termination of the building, as well as from the tower, not a little contribute. The external length, including buttresses, is 426 feet; the internal, 394: that of the nave, from the front to the west transept, 180; of the choir, including the organ-loft, 120; of the Lady-chapel, 60; of the west cross or transept, 128; and of the east transept, 120 feet. The nave is separated from the aisles by ten clustered columns on each side, supporting three ranges of pointed arches; an arrangement also carried on through the choir. A stone pulpit, originally placed near the west end of the nave, is now fixed at the north side of the choir. It is of an octagonal form, ornamented with emblematic sculpture, and surmounted by a canopy.

Worcester cathedral has, like many other edifices of the same nature, been a great sufferer by the lapse of time, and by the various modes of repair adopted at different periods. It now scarcely contains one arris or moulding, as originally constructed. Roman cornices now occupy the place of battlements; buttresses are pannelled in various heterogeneous ways; pinnacles have been restored after the Grecian school; windows formed without ramifications or cusps, and filled with modern stained glass, destitute of subject or design; Roman arches resting on entablatures, to support or strengthen the transepts; Roman squares with leaves, instead of proper bases to regular clustered pillars. Indeed this edifice affords a curious, but not a very pleasing, display of heterogeneous parts and styles.

Of the numerous monuments contained in the cathedral, a few only can be noticed in this work. Between the pulpit and the communion-table, in the midst of the choir, is placed the altar-tomb of king John, who died in 1216. On it is extended his effigy. The inscription, "Johannes Rex Angliæ," is now almost illegible. The figure, as large as life, has in the right-hand a sceptre, and in the left a sword, with its point in the mouth of a lion couchant at the feet. On each side, on a level with the pavement, are small figures of bishops Oswald and Wulfstan. It had long

been imagined that this monument was merely an honorary cenotaph, while the body of John really lay in the Lady-chapel; but by an investigation in 1797, the contrary was ascertained. Removing the effigy and stone on which it rested, the interior of the monument was laid open. Between two brick walls, and under some elm boards, lay a stone coffin containing the royal corpse. The body had evidently been deranged at some former period; but many of the parts were very perfect. Instead of the crown, however, as shewn in the effigy, the head had been invested with the hood of a monk's cowl. The body had been enveloped in an embroidered robe, seemingly of crimson damask. The coffin rested on the pavement of the choir, and the original cover was the stone on which the effigy is sculptured. On the right-hand of the communion-table, occupying one of the arcades between the choir and the fourth aisle, stands the celebrated monumental chapel or chantry of Arthur, eldest son of Henry VII., and elder brother of Henry VIII. This chapel, of an oblong form, is richly ornamented on the north, west, and south sides, by open screen-work; the pillars adorned with a number of small statues, with shields, roses, and other figures emblematic of the houses of York and Lancaster, whose contending claims to the English throne were united in that young prince, who died in 1502, in the 17th year of his age. Against the east end was placed an altar, behind which was a wall ornamented with five figures; in the centre the Saviour, on the right-hand two kings in their robes, and on the left another similar king, and a warrior in armour. Over the statues are richly-wrought canopies. To preserve those figures from destruction, they had been covered over with plaster, probably in the reign of Elizabeth, and remained thus unknown until November 1788, when the plaster being removed, they were once more laid open to view. The tomb of prince Arthur is of marble, with the arms of England and France quartered, painted on the sides; round the edge of the cover is an inscription in English.

Worcester cathedral contains also the monument of the celebrated judge Littleton, the father of English law, a justice of the common pleas under Edward IV., who died in 1481. Of more modern sepulchral monuments it will be sufficient to mention those of bishops Hough, Maddox, and Johnson, not only for the eminent names they commemorate, but as distinguished examples of modern sculpture. Attached to the south side of the nave of the church is the ancient cloister, a square of about 120 feet, on the east side of which is the chapter-house, a decagon of 58 feet in diameter, and 45 in height, the roof of which is supported by a central column: it now serves as a library, as well as a council-room, and contains a valuable collection of books, and of manuscripts, chiefly relating to the canon law. Adjoining to the south side of the cloister is the ancient refectory of the monastery attached to the cathedral, called the college-hall, a lofty and spacious room, 120 feet long by 38 broad, now kept as the king's school. Here are also held the triennial musical meetings of the three choirs of Worcester, Hereford, and Gloucester, for the benefit of the widows and orphans of the clergy of their respective counties. This school was founded by Henry VIII. for forty scholars, who are prepared for the university, and instructed in various branches of modern education. A little to the eastward of the chapter-house stands the audit-hall, anciently called the Gueiten-hall, built in 1320, for the entertainment of strangers resorting to the monastery and cathedral. It is still the scene of hospitality during the annual audits of the chapter of the cathedral. At the back

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of the seventh prebendal house, which formerly belonged to the kitchen or cook of the monastery, are the remains of the great kitchen, a spacious octagonal apartment, 34 feet in diameter.

Other places of worship belonging to the establishment in Worcester are, the churches of St. Peter the Great, St. Michael, St. Alban, St. Helen, St. Andrew, St. Clement, St. John Baptist, All Saints, St. Swithun, St. Martin, St. Nicholas, and Claines. Of these buildings, some preserve their ancient appearance. St. Andrew's church is distinguished by a square tower, 90 feet high, supporting an octagonal spire, in height 155 feet 6 inches; the whole height being 245 feet 6 inches. The church and tower are supposed to have been erected in the eleventh century, but the spire was not added till 1751. Among the various monastic institutions of Worcester was that remarkable one, now called the *Commandery*, established for the maintenance of two chaplains, five poor men, and two poor women, founded by St. Wulfstan, who died in 1097: it became, after the dissolution, a part of the endowment of Christchurch in Oxford. Commanderies were, among the knights-hospitaliers of Jerusalem, the same with the preceptories among the knights-templars; being societies placed on the country estates of the order, under the controul of a commander, but accountable to the grand prior or master in London. Part of the ancient buildings still exist; but the whole, now in the possession of a private individual, has of late years undergone great alteration.

Though containing so many parish-churches in proportion to the population, Worcester is not deficient in the number of chapels for various classes of dissenters. Among these, are reckoned Anabaptists, Independents, Methodists, Presbyterians, Quakers, and Roman Catholics.

On the south side of the cathedral and cloister is an open space, called the College-green, on the east side of which is a gate, known by the name of Edgar's tower, having on the outer front the statues of that king and his two queens, Elfreda and Elfrida. Antiquarian curiosity has been much excited by characters once existing on this tower, supposed to indicate a date much older than the received introduction of our present numerical figures into this part of the world. But the characters were probably misunderstood; nor is the tower itself believed to be of the age of Edgar, who died in 975.

Northward from the cathedral, on the rising bank of the Severn, is the bishop's palace, originally surrounded with embattled walls in 1270, but brought into its present state by bishop Stillingfleet and succeeding prelates. The west side still retains much of the antique architecture.

Public Buildings.—The chief of these is the guildhall, situated on the west side of the High-street, near the market-place. It is a handsome edifice of two spacious stories, finished in 1723: the lower part is in one room, 110 feet 6 inches long, by 25 feet 6 inches broad, and 21 feet high, in which are held the several courts of justice for the city and the county. The council-chamber is 109 feet long, by 26 broad, and 15 feet 8 inches high. The bridge over the Severn, in length between the abutments 270 feet, and in breadth 25, is an elegant stone structure of 5 semicircular arches, opened in 1781. The centre arch is in span 41 feet, but the other arches gradually diminish in width. Connected with the bridge a new street has been opened, leading into the middle of the city, and the new roads from the westward, the embankments, and quays along both sides of the river, are at once ornamental and useful.

Charitable Institutions.—The chief of these is the house of industry, completed in 1794, a handsome building on the east

side of the city, advantageously situated on an eminence, and calculated to accommodate 150 persons belonging to the different parishes of the city. The infirmary, situated in an airy position, overlooking the race-ground, the river, and the north-west parts of the county, was commenced in 1767: it receives about 58 patients on an average annually. A number of hospitals and alms-houses, some of ancient foundation, provide support for age, and education for youth. A free-school on the Lancafterian plan was established some years ago. The old county-gaol is situated in the castle-yard; but a new one has been lately erected in the neighbourhood of the infirmary, on the Howardian plan. The city-gaol is an ancient building in a crowded situation, having been originally a Franciscan convent, founded in the 13th century, but granted to the city at the dissolution.

Public Amusements.—Worcester has long maintained its claim to be one of the most fashionable cities in the western parts of the kingdom: it is consequently the winter-residence of a number of considerable families from the surrounding counties of England and Wales. The theatre, assemblies, concerts, races, the various public walks, clubs, the public library, &c. render Worcester a busy, gay, and much-frequented city.

Municipal Government.—The city was incorporated by Henry I., but the first charter was granted in the 45th year of Henry III. In 1621, the 19th year of James I., a mayor was established. The corporation now consists of a mayor, six aldermen, 24 common-council-men, and 48 assistants, by which last two bodies the magistrates are chosen. But the right of electing the members for parliament extends to upwards of 2000 citizens, the sheriff being the returning officer. Worcester sent two representatives to parliament in the 23d year of Edward I. Florence of Worcester, the author of the *Chronicon*, a general history of the world down to 1118, when he died, was a monk of the cathedral of this city. William of Worcester was educated in Oxford in 1434, and drew up his "Polyandria Oxoniensis," a history of the learned men bred in that university. His *Annals*, at the end of the "Black Book" of the exchequer, contain notes on the affairs of his own times. The famous empyric and mystic philosopher, Edward Kelly, was born in Worcester towards the middle of the 16th century. The relation of the impostures of this person and his associate Dr. Dee, furnished by Lilly, present a humiliating picture of the human mind and understanding in those days, on the continent as well as in England. Worcester produced, in 1650, the eminent lawyer lord Somers, who, by his knowledge and eloquence, defended the cause of liberty and justice in the latter part of the reign of Charles II., when but few warm and able advocates were found on their side in Westminster-hall. See SOMERS, Lord.

Worcester has long been rendered very interesting, from the circumstance of the *Royal Porcelain Works* being established within its walls. It is, on our part, a most pleasing duty, not only to trace its rise and progress, but to hold up its elegant and highly-finished productions to the attention of the liberal and scientific. A very material difference exists between this establishment, and others of a similar kind on the continent; as the improvements made by expensive experiments are here effected at the sole charge of the proprietors, while the most famed manufactories on the continent are supported and carried on at the cost of the government of the countries to which they belong. The Worcester porcelain works were founded in the year 1751, by Dr. Wall and a company of proprietors, composed of many gentlemen of fortune and consideration in the city and county; who continued to carry on the concern under those adverse circum-

stances generally attending the introduction of a *new species* of manufacture: for at that time little was known of porcelain in England, except by the imports from foreign nations. The Worcester porcelain company had the merit of discovering the method of transferring impressions from *engraved copper-plates* to the surface of the porcelain. The invention, after a lapse of several years, was conveyed into Staffordshire, and now forms a grand branch of the extensive foreign and home trade carried on in the potteries, giving employment to many thousands. The *founders* of this manufactory, besides the printing, produced neat enamelled designs, but not very superior either in design or execution. These extensive premises, situate on the banks of the Severn, were subsequently purchased by Messrs. Joseph Flight and Martin Barr, and by a liberal policy, and great exertion and expence in a long series of experiments, the productions of these works have risen rapidly in the public estimation. His present majesty, the queen, and princesses, in the year 1788, honoured the manufactory by minutely inspecting its various processes; and at this time the king graciously granted his patent, when these works were styled 'Royal,' being the first that enjoyed this distinction. His majesty condescended to suggest the establishment of a warehouse in London, and one was immediately opened in Coventry-street. The proprietors have since had the honour of receiving a patent and every encouragement from his royal highness the prince regent, the enlightened patron of the arts; and from the late princess Charlotte, as well as from other members of the royal family, and even from foreign courts; but our limits forbid our entering into detail. On the demise of Martin Barr, esq. in the year 1813, he was succeeded by his sons; and the works are now carried on under the firm of Flight, Barr, and Barr. It is not a little remarkable, that a considerable part of the export trade of the Worcester porcelain works is to our settlements in the East Indies, and even to Canton. We cannot but observe the singular change in our commercial relations in *this manufactory*; for the Chinese, who seventy years since furnished this country and nearly all Europe with porcelain, are now excluded from our markets, and thrown into the back-ground, and their extensive manufactories nearly ruined. What Wedgwood did in his coarser clays, in his beautiful imitations of the Etruscan vases, and in antique designs on jasper, will long live in the recollection of his country. The same spirit seems to actuate the proprietors of the Royal Worcester Porcelain Works, as they have spared no expence in *their finer materials*, and highly-finished models and paintings, to excel the manufactories on the continent. In these works, the utmost attention is paid to the study of historical compositions, landscapes, flowers, &c.; and the success which has attended the new method is most evident, as the productions now fairly rival the best foreign specimens. It is with peculiar pleasure we can at length announce, that we have seen a *fabric*, recently made by the present proprietors of these works, which in its colour, fracture, and transparency, is equal to the porcelain made at Sevre or Dresden. This fabric is composed *entirely of British materials*, and the fact must be the ground of triumph, after all that has been said of the impossibility of finding in this country proper materials for a *true porcelain*. The process is most curious and elaborate, of which we can but give a slight description, as its details are so numerous. It may be viewed by tickets, granted by order of the proprietors to any respectable individuals leaving their names. The materials, several of which are procured from the county of Cornwall, are first selected with great care, and some undergo a severe calcination previous to their being composed in proper proportions; they are then weighed and mixed,

and burnt in a kiln to a very intense degree of heat, and form what is termed a 'frit.' This is ground under a massive iron roller previous to an admixture of a certain proportion of the purest argil, or working clay, which is ground with the frit in a mill, the bottom of which is laid with stone, over which large stones of about fifteen hundred or a ton weight are driven by upright 'drivers,' fixed in wooden arms attached to the centre shafts; these, with water, reduce the substance to a thick white liquid, which is afterwards passed through an extremely fine lawn sieve, and is run from cisterns into large brick pans, warmed by flues underneath; the heat being sufficient to drive off, by evaporation, the water that cannot be collected on the surface, so that the residuum is a moist clay, which is afterwards tempered in stone vaults, and rendered fit for the use of the potter. The man who first brings the rude mass of clay into form, on a circular block, moved horizontally by a boy, who drives a vertical wheel, is called a 'thrower.' The dexterity and rapidity with which the clay appears to spring into the shape required seems like magic, as it is performed silently, and almost unperceived, by the pressure of the fingers and thumb. This mode of 'throwing' differs from the Chinese method, and that practised on the continent, where the thrower moves his block by the action of his feet: in the one he has the advantage of an undivided attention, and the clay is literally obedient to his touch; while in the foreign method, the thrower is distracted with two distinct operations, and at the best it can be but a clumsy exhibition. By this mode all *round vessels* derive their first formation; any article of an oval, square, or other shape, must be made off a mould formed of alabaster, prepared in a powder, and with water brought into a liquid form, when it is run on the model, and sets quite hard, presenting a case the precise reverse of the model, on which layers of clay, cut to a proper thickness, are pressed with a sponge and the hand, and the artist from this is termed 'a presser.' Great care is requisite in drying the different articles in a stove after they come from the thrower, to render them sufficiently firm to hang on a lathe, where they are reduced to a proper thickness, and a more accurate form, by a turner, who works his wheel on the same principle as one for wood or ivory. It is again committed to the stove, where it is rendered quite dry and crisp; and the surface is afterwards sponged, and then rubbed with paper perfectly smooth. In pieces which have any particular marks or decorations in the clay, they are pressed from moulds, and the handles are attached to the vessel simply by the clay reduced to a liquid form. When burnt, the union is so complete, that it appears to have been made altogether, and is perfectly as firm. We cannot trace the operations in this stage any farther, but are surprised to see how many hands the most simple article passes through, while the risk and labour in these and more elaborate specimens are very great in this tender state of the clay. From the potter's-stove the ware is carried to what is termed the biscuit-kiln, and placed in cases of fire-clay, called seggars, in which each piece requires particular supports to prevent its yielding to the fire, and losing its proper shape. Here the porcelain is burnt to an intense degree of heat, and is rendered quite white and transparent, but has a slight roughness on its surface. From hence it is carried to the warehouse, examined, freed from dust and other imperfections, and then dipped in a liquid termed the glaze, dried in a stove, and afterwards every piece is carefully examined and 'trimmed;' which consists in rendering the surface quite even, and scraping the glaze from the feet, which, if not removed, would *melt* and adhere to the cases in which they are burnt.

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From the glazing-room the articles are carried to the second kiln, and here they undergo another severe fire, which fluxes the glaze, and gives to the porcelain a beautiful glossy surface. In this kiln the losses are great, as the porcelain can have no support. It is again warehoused, examined, and delivered to the painters, who decorate it with gold, reduced by a chemical process, so that it may be worked in a liquid form. In paintings of various designs, the outline is made with a black-lead pencil, on the glazed surface, corrected with Indian ink; and the colours, all of which are prepared from mineral substances, worked in oil and spirits of turpentine, are laid on with fine camel's-hair pencils. The colours in this state are difficult for strangers to understand, as their tints are so surprisingly changed by the action of the fire; while their opaque and obscure appearance is increased at every stage of drying at a common fire, previous to their being burnt in the kiln. The finer kinds of paintings in figures, landscapes, flowers, &c. require repeated burnings, in order to give them sufficient depth and richness by working one tint over another. The enamelling kiln, in which they are fired, is rendered sufficiently hot to fuse the glaze, without occasioning it to run; while the colours, by the aid of their fluxes, are melted into the glaze, so as to render their union perfect, and give them their rich transparent effect.

The durability of these colours, which cannot be acted on by any atmosphere, renders good painting in this style very desirable. It has long been a desideratum with the greatest masters to procure colours for painting on canvas, on which time can have no injurious effect; but in this they have hitherto unfortunately not succeeded, and it was the regret of an eminent artist, that his paintings had not the permanency of porcelain colours. A method of printing, entirely different from the original mode invented by the founders of the works, is now carried on here. (For a description, see PRINTING on Porcelain, in the *Addenda*.) The last operation is the burnishing of the gold, which is executed with a stone, black in its external appearance, and remarkable for its hardness and the high polish it takes. This work is performed by women, who render the gold extremely brilliant by rubbing its surface with great care and skill. The embossed gold, for which this manufactory is celebrated, is burnished with a fineagate, which is also used in chasing and in finishing the handles of vases, &c. We have now sketched the process, but we should not omit to mention that in every stage the porcelain is very liable to accident and imperfections; and if not totally spoiled, it may require a repetition of firings, which much increases the risk and expence. The most costly articles are exposed in the fire from 150 to 200 hours, in their different stages collectively. An important colour used in porcelain manufactories is the rich dark blue, generally called 'royal.' It is prepared from cobalt, and the oxyd of this ore is so powerful as to require the heat of the glaze-kiln to bring out its beautiful tint. It is not, like other colours, worked on a glazed surface, but laid on the porcelain after the first burning, when in the rough or 'biscuit' state, then fired, and afterwards dipped in the glaze, and passed through the glaze-kiln, frequently requiring two or three such ordeals of heat to perfect its colour. We were formerly supplied with this mineral from the mines of Saxony, but have now the pleasure to learn that the proprietors of these works made some successful experiments for a company of gentlemen, who discovered cobalt-ore in Cornwall; which by a particular preparation produces as fine a blue as the Saxon cobalt, and it is now used in preference to the foreign, which can only be imported in the adulterated form of a zaffer. The reflection, that by science and labour

the rude materials of the earth are raised and converted into elegant and useful forms, and embellished with classical and tasteful designs, is highly pleasing; while it affords the means of maintenance to so many industrious workmen and ingenious artists. All the persons employed in these interesting works are British, and this manufacture stands as one proof of the increased civilization of England.—The History and Antiquities of Worcester; by Valentine Green, 2 vols. 4to. 1796. Beauties of England and Wales, Worcestershire; by F. C. Laird, 8vo. 1813. Graphic and Historical Description of the Cathedrals of Great Britain, Worcester, 8vo. 1815. History, &c. of Worcester, by J. Chambers, 8vo. 1818.

WORCESTER, the south-easterly county of the state of Maryland, with 16,971 inhabitants, including 4427 slaves.—Snowhill is the chief town.—Also, a county of Massachusetts, large and populous, with 50 townships, 53 congregational churches, and 64,910 inhabitants; 53 miles long from N. to S. and 40 broad.—Also, a town of the state of Massachusetts, containing 2577 inhabitants. This is the chief town of a county of the same name, and one of the largest inland towns in the state. It contains two churches, a town-house, and a gaol; 34 miles W. of Boston. N. lat. 42° 10'. W. long. 71° 46'.—Also, a township of Vermont, in the county of Chittenden, with 41 inhabitants; 30 miles N. of New Haven.—Also, a township of Pennsylvania, in the county of Montgomery, with 868 inhabitants; 18 miles N.W. of Philadelphia.—Also, a town of Ohio, in the county of Washington, with 385 inhabitants.

WORCESTERSHIRE, an inland county in the western part of England, bounded by Herefordshire, which separates it from Wales, on the S.W., by Shropshire on the N.W., by Staffordshire on the N., by Warwickshire on the E., and by Gloucestershire on the S. The form of the county is very irregular, having on every side detached parts surrounded by other counties, and comprehending within its bounds parts belonging to the neighbouring shires. The mean length may be estimated at about 30 miles, and the mean breadth at 25 miles, giving a surface of 750 square miles, or 480,000 acres; but according to the official report laid before parliament, the contents are reduced to 431,360 acres: about two-thirds of the county lie on the E. and one-third on the W. side of the river Severn. Worcestershire comprehends one city, eleven market-towns, three of them parliamentary boroughs, and in all 152 parishes; the whole is distributed into five hundreds. The inhabitants amounted, in 1811, to 160,546, of whom 78,033 were males, and 82,513 females, and the inhabited houses were 30,206.

Historical Events.—Worcestershire is supposed to have formed a part of the territory of the *Cornavii*, who also inhabited the contiguous districts of Warwickshire, Staffordshire, Shropshire, and Cheshire. That numerous tribe appear from the *Notitia Imperii* to have furnished bodies of troops to the Roman armies; but no trace of their name is now to be discovered in the tracts they are believed to have occupied. The county was called by the Saxons *Wirecestre-scire*, and in Domesday-book *Wirecestre-scire*, and the inhabitants in Bede's time were named *Wicci*; a term which, in the opinion of Camden, may have been derived from *Wicb*, signifying, in the old English language, a salt-pit, in allusion to the mines of that substance found in the county. Of the Roman history of Worcestershire but little is known. Ptolemy seems to take no notice of it; nor does it appear to be traversed by any of the roads traced out in the Itineraries of Antoninus. It is highly probable, however, that Worcestershire must have been the theatre of

parts of the exploits of Ostorius, when proprætor in Britain; because he was certainly posted on the *Sabrina*, now the Severn. The other river mentioned by the historians of his operations, the *Antona*, has been by some writers conjectured to be the Avon, which falls into the Severn in the S. part of the county, while others suppose it to signify the Nen of Northamptonshire. The Roman roads, of which vestiges are discovered in different parts of Worcestershire, although not known to be laid down in the Itineraries, sufficiently prove the county to have profited by the arts and the policy of the conquerors, in the opening of communications; one of the earliest and most effectual means of promoting civilization, as well as of establishing dominion, among a rude and vanquished people. One of these ancient or Roman roads is the Runced-way, or Ridge-way, on the E. side of the county, running between Worcester and Alcester, in Warwickshire: another is a paved way from Kenchester, in Herefordshire, pointing N.E. towards Worcester. The great Ikening-street enters the county from Staffordshire, and passes near Bromsgrove: another great road, supposed by Nash to be the ancient Portway, but now called the King's head-land, passes over Hagley common. According to Dr. Stukeley, a Roman road extended from Worcester down the bank of the Severn to Upton, and thence to Tewkesbury on the N. border of Gloucestershire, where it joined Ricning-streetway. Worcestershire formed a part of the Saxon kingdom of Myrcnaric, or Mercia-land, in Latin changed into Merka. This, by much the largest kingdom of that people in England, was founded by Crida about the year 586, and enlarged by Penda, under whom the Christian religion was introduced among the Merkiens. During the struggles between the native Britons and their invaders, this part of the country must have suffered severely; but at last the Britons, driven from the plains, retired behind the Severn into the mountainous tracts of Wales. The ravages of the Danes in the 9th and 10th centuries were not unknown in Worcestershire; and to that people tradition ascribes various sepulchral and military antiquities discovered in it.

During the heptarchy, the greater part of Worcestershire, Gloucestershire on the E. of the Severn, and a portion of Warwickshire, were inhabited by the *Wiccii*, and under the jurisdiction of the bishop of Worcester: but on the accession of William of Normandy, the episcopal government was superseded, and the civil power entrusted to the sheriffs of Worcester. The first of these was Urfo of Abithoth, as he is styled in Domesday-book, son of the lord of that place, in Normandy, and brother of Robert Le Despenser, ancestor of the present families of that name in England. Urfo is also styled *Vice-comes*, having received from the king the hereditary shrievalty, with the constablership of the castle of Worcester. He sat in the great councils held in London in the 15th, and in Westminster in the 18th years of William I. During the conspiracy of Roger, earl of Hereford, and Ralph, earl of Norfolk, he prevented the former from passing over the Severn to form a junction with the insurgents. His daughter and heiress, Emmeline, married Walter, the progenitor of Beauchamp, whose family afterwards became earls of Warwick. The first earl of Worcester was Walleran de Mellent, a relation of the royal family. He held also the paternal honours in Normandy; but siding with the barons against Henry I., his estates were laid waste, himself long held a prisoner, and even when enlarged not entrusted with the keeping of any of his own castles. Taking part with Stephen against the empress Maud, his city of Worcester was carried by assault, and reduced to ashes. Dying a prisoner in Normandy, his

son inherited the Norman but not the English honours. All this happened in the 12th century; and the title of earl of Worcester seems to have lain dormant until 1397, when it was conferred on Thomas Percy, son of Henry, lord Percy, by his first wife Mary, daughter of Henry Plantagenet, earl of Lancaster, and brother of Henry I. earl of Northumberland. This gallant earl of Worcester, accompanying the Black Prince to France, &c. distinguished himself under the command of John of Gaunt, duke of Lancaster. The title in 1420 was bestowed on Richard Beauchamp, of the house of Warwick, descended from the first Norman sheriff or earl. He served with great reputation in France; but dying in 1449 without male issue, the title was granted to John Tibetot or Tiptoft, baron of Powis. Under Henry VI. he was charged with the guard of the narrow seas, and appointed lord-deputy of Ireland; and by Edward IV. justice of North Wales, constable of the Tower of London, and treasurer of the exchequer. Soon after he became chancellor of the kingdom, still, however, retaining his command at sea. It was not in military and state affairs alone that this nobleman distinguished himself. Educated at Oxford in all the learning of those days, he afterwards visited Jerusalem for devotion; also Padua, Venice, and Rome, to consult the libraries and the learned societies of those places; and was the author of several works. On the temporary restoration of Henry VI. by Neville, earl of Warwick, the earl of Worcester was apprehended and beheaded at London in 1471. His son was afterwards replaced in the family honours and estates by Edward IV.; but dying without issue in 1485, the title was, by Henry VIII., conferred on Charles, natural son of Henry, duke of Somerset. His grandson, Henry, was created marquis of Worcester by Charles I.; and his grandson, Henry, was, in 1682, by Charles II. created duke of Beaufort, the title of marquis of Worcester being by courtesy attached to the eldest son of that family to the present time.

State of Property.—Prior to the Norman Conquest, great part of the lands of Worcestershire belonged to the church; but on that event much was bestowed on the favourites and followers of the Conqueror. Very little is now possessed by the descendants of the ancient proprietors; for in the various revolutions of the kingdom, the adherents of the losing sovereign were in general deprived of their property. William Beauchamp, baron of Elmley, possessed great estates by descent from the first earl of Worcester; but lost them by adhering to the empress Maud against Stephen. They were restored however by Henry II. In the contests between king John and the barons, the grandson of William Beauchamp was a material sufferer; for having taken the side of the nobles, the church of Worcester, on the re-establishment of John's power, laid hold of the opportunity to enlarge their precincts, abridging the accommodations of the castle, so that it was no longer fit for the habitation of the sheriff and his retinue; and from that time it began to fall into decay. The whole county was then the property of, or possessed by ecclesiastics, and by a few barons; nor was it until a much later period that a more general division of lands, from various causes, took place. In the reign of Richard II., the Beauchamps, earls of Warwick, were again deprived of their lands: under Henry VII. other large possessors of land, who had borne arms in Bosworth-field, were stripped of their property. But the greatest forfeiture of lands in Worcestershire took place in consequence of the attainder and execution of Edward, earl of Warwick, who had taken the part of Perkin Warbeck against Henry VII. Considerable changes were also occasioned by the transfer under Henry VIII. of the

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the lands of the dissolved religious establishments, to his favourites and the nobles who co-operated in his schemes. In the unhappy reign and life of Charles I., Worcestershire was often the theatre of warfare; many estates were dilapidated or ruined, and but few really acquired; for the prices set on the church-lands by the parliamentary surveyors were so enormous, that though sold at nominally a few years value, the purchasers generally lost by the acquisition. In later times, the changes of property in this county have been numerous and frequent; but the causes of those changes depending on private motives and not on public interests, as in former days, they do not come within the scope of this article. It is, however, worthy of remark, that out of the great number of families who recorded their armorial bearings, on the first visitation of the county by the Clarencieux, king at arms, in 1533, only six or seven now remain, and of these only two reside on the ancient family estates. Of those named in the last visitation (1683) but few descendants now exist. By these changes, however, it has happened in Worcestershire, as in other districts where manufactures and commercial enterprise prevail, that the landed property is now distributed amongst a much greater number of proprietors, and that the country is incomparably better peopled and cultivated than in former times.

General Aspect, Soil, and Climate.—When viewed from any of the numerous surrounding eminences, Worcestershire assumes the aspect of a plain, the gentle slopes and risings on the east and west of the capital being then scarcely discernible. From those eminences also the cultivation of the plains is viewed to great advantage, as there are no tracts of considerable extent so barren or so neglected as not to present an agreeable as well as profitable verdure. On a nearer view, from a hill in the centre of the county, to the eastward of the capital, a most beautiful landscape presents itself; the whole back-ground, distant from eight to twelve miles, appears to be the continuation of one range of hills, enclosing rich and beautiful plains, in which the flourishing hop-grounds and plentiful orchards constitute very interesting and gratifying objects.

The soil of the county is various; but it chiefly consists of rich loamy sand, mixed with a small proportion of gravel, in the central parts on the north of Worcester. Towards the east the soil is a very light sand, containing a few spots of clay, and some peat-earth; but the eastern district of the county is, in general, a strong clay, the waste lands being principally a deep black peat-earth. Between Worcester and the vale of Evesham, in the south-east part of the county, the soil is partly red marl, and partly strong clay, whilst the subsoil in some places is composed of lime-stone. In the celebrated vale of Evesham, watered by the river Avon, the soil is particularly deep, of a darkish earth, resting on clay, and in parts on gravel. Farther south limestone prevails, in the upper lands, on the skirts of the Cotswold hills, and a rich loam in the lower lands. In the south-west division of the county, between the Severn and the Malvern hills, the soil is in general clay, mixed with sand or gravel; but farther to the northward the gravel increases, until it terminates in the light sands of the northern border of the county. In all of these districts, however, some rocky and stony soil is found; but according to Mr. Pomeroy, in his Agricultural Survey, no traces of chalk or flint anywhere occur; nor have any been found, it is said, in the lime-quarries. The vale of Severn is described by Mr. Pitt, in his subsequent survey of the county, to contain probably ten thousand acres of a deep rich sediment, deposited in the course of ages by the river and its tributary streams. In some parts, this sediment consists of a pure

water-clay, fit for brick-making, but generally of a rich mud, fertile and favourable to vegetation. The county has been lately distributed in the following manner:

	Acres.
Common fields of arable land estimated at	20,000
Inclosed ditto - - - - -	340,000
Permanent grass-land - - - - -	100,000
Kitchen-gardens, &c. - - - - -	5,000
Woods, wastes, rivers, roads, &c. - - - - -	35,000
Whole county about - - - - -	500,000

Respecting the corn-produce of the county, it is thus estimated in Pitt's survey: In 360,000 acres of arable land, 43,500 are supposed to be laid down in wheat, yielding from 20 to 32 bushels *per* acre, or 1,200,000 bushels on an average. From this quantity deducting 108,750 bushels, at $2\frac{1}{2}$ *per* acre, the remaining neat produce is 1,091,250 bushels.

The climate of Worcestershire, particularly in the middle, southern, and western parts, is stated to be remarkably mild, soft, and healthy. The vale of the Severn rises but little above the sea, and the valleys of the Avon and Teme are nearly on the same level; and the adjoining uplands, seldom rising at the most 150 feet higher, possess a warmth and softness which ripen the grain and bring to perfection the fruits of the earth, from a fortnight to a month earlier than in more elevated counties, even enjoying a similar soil and surface. The principal bleak and inclement parts are the Bredon and Broadway hills on the south border of the county, and the Lickey range on the north: for the Malvern hills on the west, although only sheep-pasture, possess a most salubrious climate.

Hills.—The highest hills are certain points of the Lickey range, which, rising to the north-east of Bromsgrove, runs north towards Hagley, and diverges to the eastward. Some of those points are estimated to be elevated 800 or 900 feet above the general level of the country. On this range is a small spring producing two streams, one of which flows northward to the Rea, which falls into the Trent, and with it is discharged into the German ocean on the east side of the island; the other, falling into the Stour, is carried by the Severn into the Bristol Channel on the west. Bredon-hill, in the south-east corner of the county, is of about equal elevation. The highest point of the Malvern range of hills, called the Herefordshire beacon, rises, according to the great ordnance survey of England, 1444 feet above the level of the sea: the Worcestershire beacon, barometrically measured, rises 1298 feet; and North-hill 1211 feet above the Severn.

Rivers.—These are, the Severn, the Avon, the Teme, and the Stour; the smaller streams are, the Salwarp, Arrowe, Ledden, Rea, &c. The Severn, called by the Romans *Sabrina*, is supposed to be so named from the British terms *sabr*, sand, or *sabrin*, sandy, because it is often turbid, especially when heavy rains fall on the Welsh mountains. See SEVERN.

The river Avon is said to have been originally so named by the Britons, on account of the gentleness of its course. It is commonly distinguished from a number of other rivers in Britain of the same name, as the Warwickshire-Avon, and will be ever memorable while the name of Shakspeare remains. Entering Warwickshire towards the south-east corner, the Avon, by a winding course, waters the vale of Evesham, passes by Pershore, and unites with the Severn in the neighbourhood of Tewkesbury. It is navigable for barges

barges through the whole extent of the county, by means of locks in different places. See AVON.

The Teme, rising in Radnorshire, enters Worcestershire a little above Tenbury, and thence pursuing a winding but rapid course, through a succession of beautiful and romantic scenery, along the woods and dales of Stanford, the seat of sir Edward Winnington, bart., it is lost in the Severn below Worcester. From the declivity of its bed, and consequent rapidity, it is navigable for barges only up to Powick bridge, a mile and a half from the Severn. But although on this account the Teme be of little commercial use, it is peculiarly ornamental to the county, no part of which surpasses the banks of this stream in variety of ground, wood, and open lawn. A ramble along its various windings, extending upwards of twenty miles, through a succession of orchards, hop-grounds, corn and pasture land, is, in autumn, peculiarly agreeable. The Stour, an inconsiderable stream, has risen into notice since the opening along its course of the important canal by Kidderminster, uniting the Severn and the Mersey. The Salwarp pursues its short course to the Severn by Bromsgrove and Droitwich, where it formerly received the overflowings of the salt-springs, but these are now turned into the new canal from that town to the Severn. The other little streams of Worcestershire merit no particular notice.

Canals.—Connected with the natural rivers are the artificial canals opened throughout the county. These are, the Trent-and-Severn, or the Staffordshire and Worcestershire canal, more commonly called the Stourport canal, from the place where it falls into the Severn, eleven miles north from Worcester; the Droitwich canal, for the conveyance of the produce of the salt-springs to the Severn; the Worcester and Birmingham canal; the Dudley extension canal; and the Leominster canal, near Tenbury. See CANALS.

Woods and Forests.—About the time of the Norman Conquest, Worcestershire was considered to possess five forests; namely, those of Feckenham, Ombersley, Horewell, Malvern, and Wyre; but of the last only a small portion lies within the county. Feckenham forest, once very extensive, has now almost disappeared, owing to the continual demand for fuel to the salt-works at Droitwich, until of late years a sufficient supply of pit-coal has been obtained. Ombersley forest, on the north of Worcester, and Horewell forest on the south, have long been disafforested. Malvern forest or chase extended between the Severn and the summit of the hills of the same name, where may still be traced the trench which divided the forest and the county from Herefordshire on the west. Wyre forest, on the north border of the county, now more properly belongs to Shropshire and Staffordshire. Besides the vestiges of these forests, the county contains several tracts of woodland, of oak, elm, and beech: but from the demand for young trees to make hop-poles, and for trees to be converted into charcoal for the iron-works in the neighbouring counties, much timber of superior size cannot now well be expected in Worcestershire.

Mineralogy.—The minerals of this county are neither numerous nor peculiarly valuable. Clay and lime-stone are abundant; but coal, to render the latter useful in agriculture as well as building, is not easily procured where the stone is found. Some coal is indeed raised in the north-west district, about Mamble, where is a rail-way leading to the Leominster canal. Coal is also found at Penfax, and the Whitley-hills, in the same quarter, and is much used for coke for the hop-kilns and lime-pits; but the vein is too thin to promise much advantage to the county at large, which is principally supplied from the Staffordshire mines, by means of the Severn. In the vale of Evesham, and many other parts of the county, fuel is particularly

scarce and dear. The lime-stone quarries about Dudley are very extensive, and extremely curious excavations: but although the town stands in a detached part of the county, inclosed by Staffordshire, those quarries actually belong to the latter county. Building-stone of different sorts is also found in several parts. But the principal mineral riches of Worcestershire arise from the salt-mines of Droitwich, a parliamentary borough, situated six miles north-east from Worcester, on the road to Birmingham. These salt-works are of great antiquity, having been granted by Kenulph, king of Mercia, to the church of Worcester, in 816; and it appears from Domesday-book, that shares in them were annexed to many estates at even a considerable distance, on account probably of the wood they yielded for the manufacture of the salt. The principal brine-pits, however, belonged to the crown, but were granted by king John to the burgesses of Droitwich. The general substratum of the environs of the town is supposed to be a salt-rock, lying usually from 150 to 200 feet below the surface. On boring in any part, the salt-springs are met with about 110 feet below the surface: the boring-machine then passes through about 130 feet of gypsum to the brine-river, in depth about 22 inches, beyond which is a bed of salt-rock hitherto unexplored. In searching for this brine-river some years ago, the miners passed through four feet of mould, 32 of marle, 40 of gypsum, a brine-river of 22 inches, and 75 feet of another stratum of gypsum, below which they came to the salt-rock. (See DROITWICH and SALT.) For an account of the mineral waters of *Malvern*, see that article; and more particularly the paper of Mr. Horner, in the first volume of the Geological Society of London. Besides these, Worcestershire has some chalybeate springs at Sandbourne and the Round-hill, in the parish of Kidderminster.

Manufactures and Commerce.—The commerce of Worcestershire is considerable, from its own productions, and from the deposit and transit of those of the neighbouring mining and manufacturing districts. Of its own products may be noticed the hops, fruit, cyder, and perry, which render the capital the principal mart for those articles in the western part of the kingdom. The county also exports a considerable surplus of its own manufactures, consisting of Kidderminster stuffs and carpets; of Worcester gloves, china and glass-ware, and of nails, bar and sheet iron. Great quantities of salt are annually sent from Droitwich; Evesham furnishes oil and oil-cake; timber, grass-seeds, corn, flour, malt, salmon, cattle and sheep, and other agricultural productions are furnished by the county in general.

Civil and Ecclesiastical Divisions.—Worcestershire is divided into five hundreds; viz. Ofwaldeflow, Halfshire, Dodding-ton, Perfhore, and Blackenhurst: the first containing the capital and the centre of the county, with several detached portions in other quarters; the second occupying the north-west parts; the third, the north-east; the fourth, the south; and the fifth, the south-east quarter, around Evesham. In ecclesiastical matters, the county is under the government of the bishop of Worcester, and contains 152 parishes. The diocese was formerly of great extent; but in 1541 the see of Gloucester, and in 1542 that of Bristol, being erected, a considerable part of the episcopal jurisdiction of Worcester was withdrawn. At present the bishopric comprehends all the county, with the exception of 15 parishes and 8 chapelries belonging to Hereford; about one-third part of Warwickshire, together with the parishes of Brome and Clent in Staffordshire, and Hales-Owen in Shropshire. The diocese thus contains 116 rectories, 79 vicarages, 26 curacies, and 41 chapelries, all distributed into 9 deaneries.

Parliamentary History.—Worcestershire has been represented in parliament ever since the third year of Edward III., and at and ever since the revolution has maintained a respectable character for independence in the choice of its representatives. In the early part of the last century, sir John Pakynton accused the bishop of interfering in the election, of forbidding the clergy to vote for sir John, of threatening the tenantry of the see not to renew their leases if they voted for him, and even of desiring the baronet to withdraw his pretensions. The charges were established; and after a long contest between the two houses of parliament, on an address to queen Anne, the bishop was dismissed from his office of almoner. Worcestershire, which is included in the Oxford circuit, sends nine members to parliament; viz. two for the county, two for the city of Worcester, two for each of the boroughs of Droitwich and Evesham, and one for the borough of Bewdley.

Mansions and Country-seats.—Of these, Worcestershire contains a very considerable number, some of which are highly deserving of notice. Hagley-park, the “British Tempe” of Thomson, the favourite seat of the ingenious and amiable lord Lyttelton, the historian of Henry II., is situated toward the northern frontier of the county. The grounds have long been celebrated for variety and beauty of scenery. Croome-court, the handsome seat of the earl of Coventry, eight miles to the south of Worcester, is more indebted to modern art and skill for its beauties than to the natural features of the ground. The agricultural improvements, chiefly carried on by the late earl, are both extensive and important. Six miles north from Worcester is Omberley, the residence of the marchioness of Downshire, in the midst of spacious grounds. The house has been lately modernized. Grafton-hall, about a mile west from Bromsgrove, the property of the earl of Shrewsbury, was in ancient times a capital mansion; but being burned down in 1710, the porch and a part of the hall alone remain as specimens of its original magnificence. The latter has been converted into a chapel for a modern building annexed. Madresfield, six miles south-west from Worcester, the residence of viscount Beauchamp, is an ancient baronial castle, greatly altered in the modern style. Whitley-court, the seat of lord Foley, eight miles north-west from Worcester, is a highly improved and spacious mansion, in the midst of an extensive park. The parish-church, closely adjoining to the house, is one of the most elegant in the kingdom. Annexed to the see of Worcester is the ancient castle of Hartlebury, the residence of the bishops from the time of Henry III., situated between nine and ten miles north from Worcester. The principal part of the buildings, as they now stand, is the work of bishop Hough. Much of the improvements, however, are due to the late bishop Hurd, who furnished the palace with a valuable library, for the use of his successors in the see, in which are the principal books from the libraries of Mr. Pope and bishop Warburton.—Collections for the History of Worcestershire, by the Rev. Tredway Nash, D.D. 2 vols. fol. Lond. 1781-2. Supplement to ditto, ditto, 1799. General View of the Agriculture of the County of Worcester, by William Thomas Pomcroy, 4to. Lond. 1794. General View of the Agriculture of the County of Worcester, by W. Pitt, 8vo. Lond. 1813. Beauties of England and Wales, Worcestershire, by F. C. Laird, 8vo. Lond. 1816.

WORCUM, or **WoudricheM**, or *Wodercum*, a town of Holland, situated on the south side of the Wahal, first surrounded with walls in 1460, and defended with four bastions; 13 miles E.N.E. of Dort.

WORCUM, a sea-port town of Friesland, situated in a

fertile country, but subject to inundations of the sea, especially when the wind blows from the east. The harbour is blocked up with sand, but it carries on a considerable trade by means of its canals; 18 miles S.W. of Lewarden. N. lat. 53°. E. long. 5° 35'.

WORD, in *Language*, is an articulate sound, designed to represent some idea.

WORD, in *Writing*, is an assemblage of several letters, forming one or more syllables, and signifying some thing.

The Port-royalists define words to be distinct articulate sounds, agreed on by mankind for conveying their thoughts and sentiments.

The proper character of a word, according to the ingenious Mr. Harris, is that of its being a sound significant, of which no part is of itself significant; and hence he infers, that words are the smallest parts of speech.

The first and most obvious distinction of words is into such as are significant absolutely or by themselves, and such as are significant by relation: the former may be called principals, and the latter accessories. Moreover, all words whatever, significant as principals, are either *substantives* or *attributives*; and those, which are significant as accessories, acquire a signification either from being associated to *one word*, in which case they only define and determine, and may justly be called *definitives*, or to *many words at once*, in which case they serve to no other purpose than to connect, whence they are called *connectives*. Accordingly, Mr. Harris refers all words to these four species. Hermes, p. 20, &c. See **SPEECH**.

Grammarians divide words into eight classes, called *parts of speech*; which are, the *noun*, *pronoun*, *verb*, *participle*, *adverb*, *conjunction*, *preposition*, and *interjection*; to one or other of which, all the words and terms in all languages, which have been, or may be invented to express our ideas, are reducible. See each.

Words, again, are divided into *primitives* and *derivatives*, *negative* and *positive*, *simple* and *complex*, *common* and *proper*, *abstract* and *concrete*, *synonymous* and *equivocal*.

With regard to their syllables, words are farther divided into *monosyllables* and *polysyllables*.

The grammatical figures of words, which occasion changes in the form, &c. thereof, are, *syncope*, *apocope*, *apostrophe*, *diarexis*, *apharexis*, *prosthesis*, *epenthesis*, *paragoge*, *metathesis*, &c. See **SYNCOPE**, **APOCOPE**, &c. See also **FIGURE**.

The use of words, we have observed, is to serve as sensible signs of our ideas; and the ideas they stand for in the mind of the person that speaks, are their proper significations.

Simple and *primitive* words have no natural connection with the words they signify; whence there is no rationale to be given of them: it is by a mere arbitrary institution and agreement of men, that they come to signify any thing. Certain words have no natural propriety or aptitude to express certain thoughts, more than others: were that the case, there could have been but one language.

But in derivative and compound words the case is somewhat different. In the forming of these, we see a regard is to be had to agreement, relation, and analogy: thus most words that have the same ending, have one common and general way of denoting or signifying things; and those compounded with the same prepositions, have a similar manner of expressing and signifying similar ideas in all the learned languages where they occur.

For the perfection of language, it is not enough, Mr. Locke observes, that sounds can be made signs of ideas; unless these can be made use of, so as to comprehend several

particular things; for the multiplication of words would have perplexed their use, had every particular thing needed a distinct name to be signified by.

To remedy this inconvenience, language had a farther improvement in the use of general terms, by which one word was made to mark a multitude of particular existences; which advantageous use of sounds was obtained only by the difference of the ideas they were made signs of: those names becoming general, which are made to stand for general ideas; and those remaining particular, where the ideas they are used for are particular.

Some of our philosophers have complained much of the great use, or rather abuse, of vague and general terms, which have no precise definite signification. To distinguish these, F. Malebranche observes, that every thing that is, and consequently every thing that is intelligible, is either a being, or a mode and manner of being. Hence it is evident, that every term which does not signify either of these, signifies nothing, and is an obscure and confused term. In metaphysics, the use of such terms, he says, is sometimes necessary and allowable, as in speaking of the divine perfections, &c. But in physics it is always mischievous, however common.

It is observable, that the words which stand for actions, and notions quite removed from sense, are borrowed from sensible ideas; as, to imagine, apprehend, comprehend, understand, adhere, conceive, instil, disgust, disturbance, tranquillity, &c. which are all taken from the operations of things sensible, and applied to modes of thinking. *Spirit*, in its primary signification, is no more than breath; *angel*, a messenger. By which we may guess what kind of notions those were, and whence derived, which filled the minds of the first beginners of languages; and how nature, even in the naming of things, unawares, suggested to men the originals of all their knowledge: whilst, to give names that might make known to others any operations they felt in themselves, or any other ideas that came not under their senses, they were forced to borrow words from the ordinary and known ideas of sensation.

The ends of language, in our discourse with others, are chiefly three: first, to make our thoughts or ideas known one to another. This we fail in, 1. When we use names without clear and distinct ideas in our minds. 2. When we apply received names to ideas, to which the common use of that language doth not apply them. 3. When we apply them unsteadily, making them stand now for one, and anon for another idea.

Secondly, to make known our thoughts with as much ease and quickness as is possible. This men fail in, when they have complex ideas, without having distinct names for them; which may happen either through the defect of a language, which has none; or the fault of the man, who has not yet learned them.

Thirdly, to convey the knowledge of things. This cannot be done, but when our ideas agree to the reality of things. He that has names without ideas wants meaning in his words, and speaks only empty sounds. He that has complex ideas without names for them, wants dispatch in his expression. He that uses his words loosely and unsteadily, will either not be minded, or not understood. He that applies names to his ideas, different from the common use, wants propriety in his language, and speaks gibberish; and he that has ideas of substances, disagreeing with the real existence of things, so far wants the materials of true knowledge.

WORDS, *Division of*. See DIVISION.

WORDS, *General*. See GENERAL.

WORDS of Command. See EXERCISE.

WORD, *Watch-Word*, in an *Army* or *Garrison*, is some peculiar word or sentence, by which the soldiers are to know and distinguish one another in the night, &c. and by which spies and designing persons are discovered.

It is used also to prevent surprizes. The word is given out in an army every night by the general, to the lieutenant, or major-general of the day, who gives it to the major of the brigades, and they to the adjutants; who give it first to the field-officers, and afterwards to a serjeant of each company, who carry it to the subalterns.

In garrisons it is given, after the gate is shut, to the town-major, who gives it to the adjutants, and they to the serjeants.

WORD, in *Heraldry*, &c. See MOTTO.

WORDS, *Defamatory, Treasonable*, &c., in *Law*. See DEFAMATION, SCANDAL, and TREASON.

WORDEN, in *Geography*, a town of the duchy of Holstein, on the right side of the Elbe; 10 miles N.W. of Gluckstadt.

WORDEN, *Grossen*, a town of the duchy of Bremen; 10 miles N.N.W. of Stade.

WORDERNBERG, a mountain of the duchy of Stiria; 6 miles S.S.E. of Eisenhartz.

WORDINGBERG, a sea-port of Denmark, situated on the fourth coast of the island of Zealand, opposite the island of Falster. In the year 1066, Waldemar I. built a strong castle here, which is now gone to decay. Waldemar III., who was exceedingly fond of this place, resided here for the most part; and in derision of the Hanse towns, built the well-known tower, which, from a golden goose erected on the top of it, he called *Gans*, that is, *The Goose*. In this tower, he purposed to confine the prisoners of the Hanse towns that should fall into his hands in the war he intended to carry on against them. As the old castle gradually fell to decay, prince George, who was brother to Christian V., and married to Anne, queen of England, built here an entire new castle, which Frederick IV. afterwards enlarged; but that edifice has been pulled down. The usual passage to the islands Falster and Laaland is from this place. In 1240, at a famous diet held here, the Old Justische Low-buck, or Codex Legum Juricarum, was compiled and promulged: this body of laws is still in force in South Jutland. In 1256 another diet was held here; and in 1658, preliminaries for a peace between Denmark and Sweden were treated of in this town; 43 miles S.W. of Copenhagen. N. lat. 55° 3'. E. long. 11° 58'.

WORE. See WYRE.

WORENZUTTE, a town of Prussia, in Ermeland; 8 miles S. of Heilsberg.

WORGAN, Dr. JOHN, in *Biography*, a musical graduate of Oxford, organist of St. Mary-Axe, Bedford chapel, and many years a distinguished performer on the organ at Vauxhall, and Dr. Arne's successor there in the composition of cantatas, songs, and ballads.

He learned the rudiments of music of his elder brother, who had likewise an organist's place in the city, and played the violoncello in the Vauxhall band. Their scholars on the harpsichord were very numerous, particularly within Temple-bar; and John, as an organist and opener of new organs, rivalled Stanley. He was a very studious man, and dived very early into the old ecclesiastical composers of Italy. He succeeded Gladwin in playing the organ at Vauxhall. His first study in composition and organ-playing was directed by Roseingrave, who pointed his attention to the pure harmony and modulation of Palestrina, and organ-fugues of Handel. His constant use of the organ at Vauxhall, during the summer,

summer, ranked him with Stanley and Kceble; and his enthusiasm for Scarlatti's lessons, with which he was impressed by Roseingrave, rendered him equal to Kelway in their execution.

With an extempore prelude, *alla Palestrina*, and one of Handel's organ-fugues, he used to preface his concerto every night.

At length he got acquainted with Geminiani, swore by no other divinity, and on consulting him on the subject of composition, he was told that he would never be acquainted with all the arcanæ of the science, without reading "El Porque della Musica," a book written in Spanish per Andres Lorente, en Alcalá, 1672. But where was this book to be had? Geminiani told him, and told him truly, that the tract was very scarce. He had, indeed, a copy of it himself; but he would not part with it under twenty guineas. Worgan, on fire to be in possession of this oracular author, immediately purchased the book at the price mentioned; not understanding a word of Spanish, he went to work in learning it as eagerly as Rowe the poet, when lord Oxford had expressed a wish that he understood that language, which Rowe thought would qualify him for a good place under government. But after hard drudgery, when he hastened to acquaint the minister of state that he thought himself a tolerable master of the Spanish tongue, "I give you joy (says lord Oxford); you are now able to read Don Quixote in the original."

The knowledge of Spanish and study of Lorente seem to have had no other effect on Worgan's compositions, than to spoil his Vauxhall songs; which though sung into popularity by dint of repetition, had no attractive grace, or pleasing cast of melody.

He composed several oratorios, in which the chorusses are learned, and the accompaniments to his songs ingenious. The *cantilena* was original, it is true, but it was original awkwardness, and attempts at novelty without nature for his guide.

His organ-playing, though more in the style of Handel than of any other school, is indeed learned and masterly, in a way quite his own. In his youth, he was impressed with a reverence for Domenico Scarlatti by old Roseingrave's account of his wonderful performance on the harpsichord, as well as by his lessons; and afterwards he became a great collector of his pieces, some of which he had been honoured with from Madrid by the author himself. He was the editor of twelve at one time, and six at another, that are admirable, though few have now perseverance sufficient to vanquish their peculiar difficulties of execution. He is still in possession of many more, which he has always locked up as Sybil's leaves.

He had the misfortune to labour under two dreadful calamities; a bad wife, and the stone. He got rid of the former, after great mortifications and expence, by divorce; but in too early wishing to abridge his sufferings from the latter, he lost his life in the torture of an operation, August 20, 1790.

WORGÄUM, in *Geography*, a town of Hindoostan, in the country of the Mahrattas; 20 miles W. of Poonah.

WORK, in the *Manege*. To work a horse, is to exercise him at pace, trot, or gallop, and ride him at the manege.

To work a horse upon volts, or head and haunches in or between two heels, is to passage him, or make him go sideways upon parallel lines.

To **WORK**, in *Sea Language*, is to direct the movements of a ship, by adapting the sails to the force and direction of the wind. A ship is also said to work when she strains and

labours heavily in a tempestuous sea, so as to loosen her joints or timbers. See **ROLLING**.

WORK, *Carpenter's, Clock, Crown, Field, Fire, Fret, Grotesque, Horn, Mosaic, Out, Regimen of the, Rustic, Scratch, Stream, Vermicular, and Wax*. See the several articles.

WORK, *Discharge*, in *Calico-Printing, &c.* a peculiar kind of process, in which the cloth is first dyed of some uniform colour, by means of a mixture of iron-liquor and some one or more of the common vegetable dyeing substances; and calicoes thus prepared are said to be dyed of self-colours. They are then washed and dried, and when properly pressed or calendered, they are fit for receiving any pattern, according to the views of the artist. This operation is generally effected by means of the mineral acids, previously fitted for the purpose by dissolving in them a portion of one or more of the metals, according to the nature of the dye which is intended to be *discharged*, or of the colour to be produced. In doing this, the discharging liquor should be so made as to be capable of dissolving the iron which is contained in the dye, and which is always used in quantity sufficient for covering, or at least disguising in a great measure, the other colour or colours which had been employed with it, and at the same time for acting as a mordant in beautifying and fixing those colours. Thus a piece treated with a decoction of Brazil-wood, and dyed black by being *padding* with iron-liquor, if when dried it be printed with a peculiar solution of tin, the ferruginous portion of the dye will be dissolved, and the printed part will be instantly converted from a deep black to a brilliant crimson. The term *padding* denotes the operation of passing the pieces from a roller through a trough containing a solution of iron, or any other mordant, and is synonymous with *blotching*. In the same way, an olive-coloured calico, dyed in a solution of iron and a decoction of weld, will be as speedily changed to a bright pale yellow; and the various drabs and flates of every shade which have been in their composition, will undergo as sudden a change by the same treatment; though the colour of the figures produced upon them will depend on the materials with which the cloths were originally dyed. Even the deepest gold colours, or strongest buffs, if produced by iron only, may, by a peculiar preparation of tin, be discharged; and those parts of the cloth which have been treated with this metallic solution, will be restored to their former whiteness. Calicoes also, dyed of a light blue in the indigo-vat, then passed through sumach and copperas, and finished in a bath of quercitron bark and alum, may have figures of a bright green imparted to them. In this case, the green is originally formed by means of the indigo-vat and the bark, though it is enveloped by the iron of the copperas, which overcomes the other colours, till the solution of the tin is applied, which removes the iron from those particular parts, and gives a brilliancy to the remaining colour, which they would not otherwise have possessed; the tin being a powerful mordant for the bark, by which the yellow of the green is procured. A good self-colour may likewise be given to calicoes, merely by dyeing them in sumach and copperas, and then running them through an alkaline solution of annotto; and here the figures produced by the application of a colourless solution of tin will be of a bright orange.

In the instances above cited from Mr. Parkes's *Essays*, vol. ii., he refers only to that branch of discharge-work in which all the purposes are attained by dissolving the iron that makes a part of the colour intended to be discharged; whereas the finer and more expensive work is done by a different process. The particular kind of chemical discharge-

work above-described is subject to the imperfection of not being perfectly fast; that is, the goods thus produced will not bear frequent washing like those which are done by the bath of madder or bark. In this connection with permanent colours, Mr. Parkes is led to mention a very valuable *green*, not long ago invented by a Mr. Iset of London, secured to him by patent, which was produced by printing ground indigo, mixed with a peculiar kind of solution of tin, and then fastening the indigo within the fibres of the calico, by means of that process denominated *china-blue dipping*. (See *DIPPING*.) After this, the goods are to be dyed in a copper of bark or weld, which converts the blue into a green, and the whites are to be cleaned by croft-bleaching, &c.

In another kind of discharge-work, the agent that is employed is the citric acid, in various degrees of concentration, according to the purpose to which it is to be applied, or the strength of the ground intended to be discharged. This is employed chiefly for the production of white figures upon self-coloured grounds produced by madder and sundry other dyes. The acid for this purpose is mixed with either gum or paste to a proper consistency for the black, the plate, or the cylinder, and from thence it is transferred to the piece; and wherever it attacks, the mordant, whether iron or alumine, is discharged, and a delicate white appears in its stead. In using citric acid for this purpose, a portion of one of the mineral acids is sometimes mixed with it. There is another species of discharge, on which the agent employed by the printers is the nitrous, and sometimes the nitro-muriatic acid. See *DISCHARGING of Colour* and *COLOUR*.

WORKALLEN, in *Geography*, a town of Prussia, in Oberland; 4 miles S.W. of Liebstadt.

WORK-HOUSE, a place where indigent, vagrant, and idle people are set to work, and maintained with clothing, diet, &c. See *HOUSE of Correction*.

Such are the Bridewells, and several other places about the city of London, or suburbs; such also was the foundation of that in Bishopsgate-street, for employing the poor children of the city and liberties, who have no settlement; and that for the parish of St. Margaret's, Westminster, called the Grey-coat hospital.

By 43 Eliz. cap. 2. the church-wardens and overseers, with the consent of two justices, are empowered to set to work the children of the poor and other destitute persons, and to provide for the relief of the lame, old, blind, and such as are poor, but not able to work; and they may erect, with the leave of the lord of the manor, on any waste or common, of which the parish is parcel, convenient houses of dwelling for the poor. (See *POOR*.) By 3 Car. IV. they may set up and use any trade, merely for the employment and relief of the poor. By 9 Geo. cap. 7. they may contract for the maintenance and employment of the poor in houses purchased or hired; and poor persons refusing to be lodged and maintained in such houses, shall be put out of the parish-books, and not entitled to receive relief from the church-wardens and overseers; and two or more parishes are allowed to unite in lodging their respective poor in one house; and the officers of one parish are allowed to contract with those of another for the maintenance, &c. of their poor. Moreover, by 8 & 9 Will. cap. 30. parish poor that are relieved are required to wear on the shoulder of the right sleeve of the uppermost garment, in red or blue cloth, a large Roman P, together with the first letter of the name of the parish or place to which they belong. By 24 Geo. II. cap. 43. no spirituous liquor shall be sold or used in any work-house, or house of entertainment for parish poor. The statute 22 Geo. III.

cap. 83. establishes many new regulations with regard to the maintenance of the poor; but leaves it optional in any parish or place whether they will adopt these, or retain the present mode. At Amsterdam they have a famous work-house, or house of correction, called the *Rasphuyse*, (which see,) which, by a privilege granted in 1602, has alone the right of shaving and cutting the dyer's woods, as brasil, fantal, campechy, saffaras, &c. Each person, tolerably strong, kept in the house, is obliged to furnish two hundred and fifty pounds of rasped wood *per day*; and the weaker, a certain proportionable quantity of chips.

WORKING to Windward, in *Sea Language*, denotes the operation by which a ship endeavours to make a progress against the wind. See *BEATING, PLYING, TACKING, and TURNING*.

WORKING Furnace. See *FURNACE*.

WORKING of Glafs. See *GLASS*.

WORKINGTON, in *Geography*, a considerable market and sea-port town in the ward of Allerdale-above-Derwent, county of Cumberland, England, is situated on the borders of the river Derwent, at the distance of 34 miles S.W. by W. from Carlisle, and 310 miles N.W. by N. from London. The manor was anciently possessed by the Culwens, now Curwens, a family of great consequence in the county, of whom eight out of ten, in successive descent, were knights of the shire. The present importance of the town has originated from the working of the collieries since the reign of queen Elizabeth, at which period the entire maritime strength of the county consisted of only twelve vessels, though the number now belonging to this port alone is more than 160, and many of them are from one to three hundred tons burthen. These are principally engaged in the exportation of coals to Ireland, and some few to the Baltic. The river is navigable to the town for ships of four hundred tons; and on each bank, near the mouth, are piers. The harbour is one of the safest on the coast; and many improvements have been recently made in the situation and construction of the quays. The appearance of the town is diversified: several of the ancient streets are narrow and irregular; those of modern erection are better formed; the public buildings are all of late date. The houses are principally disposed in two clusters: in that called the Upper Town a new square has been erected, in the area of which is the corn-market; at a little distance are the butchers' shambles. The church, a neat edifice, contains the monument of sir Patrick Curwen, baronet, who died in 1661. In the town are meeting-houses for Presbyterians and Methodists, and a Catholic chapel; also a theatre and an assembly-room. Two large weekly markets are held on Wednesdays and Saturdays for meat and other provisions. Corn is sold only on the Wednesdays, which is the principal market-day. Here are also two annual fairs for cattle, but of no great note. The principal manufactures are those of sail-cloth and cordage, and every thing connected with shipping. Vessels of from four to five hundred tons, copper-bottomed, are built here, and sold to the merchants of Liverpool, Cork, &c. In the population return of the year 1811, the town of Workington is stated to contain 1059 houses, and 5807 inhabitants. The parish includes the townships of Great Clifton, Little Clifton, Stainburn, and Winscales, making an addition of 726 to the population, and of 161 to the number of houses.

On an eminence, near the east end of the town, overlooking the river Derwent, is Workington-hall, the seat of John Christian Curwen, esq., who has nearly rebuilt it, from the designs of Mr. Carr of York, and greatly extended and improved the park and pleasure-grounds. The old mansion,

manſion, of which there are ſcarcely any remains, was caſtelled, purſuant to a licence granted by Richard II. to ſir Gilbert de Culwen in 1379. Mr. Gough obſerves, that the walls were ſo remarkably thick, that in making ſome recent improvements, a paſſage was excavated through one of them lengthways, leaving ſufficient thickneſs on each ſide to anſwer every purpoſe of ſtrength. In this manſion, Mary, queen of Scots, when ſhe landed in England in 1568, was hoſpitably entertained by ſir Henry Curwen, till he was required by queen Elizabeth to reſign his royal gueſt, who was removed to Cocker-mouth caſtle, and afterwards to that of Carlisle.—*Beauties of England and Wales*, vol. ii. Cumberland, by J. Britton and E. W. Brayley, 1802. *Lyfons's Magna Britannia*, vol. iv. 4to. Cumberland, 1816.

WORKS, OPERA, in *Fortification*, the ſeveral lines, trenches, ditches, &c. made round a place, an army, or the like, to fortify and defend it. See **LINE, PARALLEL, and TRENCH**.

The principal works in a fortrefs, or fortified place, ſee under **FORTIFIED Place, FORTIFICATION, &c.**

WORKS, Covenant of, in *Theology*. See **COVENANT**.

WORKSBORN, in *Geography*, a river of Northumberland, which runs into the North Tine.

WORKSOP, a market-town in the hundred of Baſſetlaw, and county of Nottingham, England, is ſituated 22 miles N. from Nottingham, the ſame diſtance N.W. from Newark, and 146 N. by W. from London. The town is ſmall, but neat and pleaſantly ſeated in a valley, near the ſource of the river Ryton. According to the population returns of 1811, the houſes were then 759; and the inhabitants 3702. A market, noted for malt, is held on Wedneſday, and fairs on the 20th of March, 20th of May, 21ſt of June, and 3d of October. Worksop, anciently Wirkenſop, was, before the Norman Conqueſt, the property of a Saxon nobleman. Long afterwards it belonged ſucceſſively to the families of Furnival, Nevill, and Talbot, earls of Shrewsbury. The Talbot eſtates deſcending to co-heireſſes, a part was conveyed to the Howards, earls of Arundel, afterwards dukes of Norfolk, by whom the lands of Worksop are ſtill poſſeſſed, and who, on this account, enjoy the privileges of furniſhing a glove for the king's right-hand at his coronation, and of ſupporting that hand while he holds the ſceptre. Worksop was in former times defended by a caſtle, long ago deſtroyed: but its ſcite is ſtill pointed out on a circular hill, encompassed with a trench, at the W. ſide of the town.

Worksop was formerly noted for its manſtery, founded by William de Lovetot, in the reign of Henry I., for canons regular of the order of St. Auguſtine. The inſtitution was ſubſequenty enriched by the gifts of various proprietors of the town; but at the general diſſolution its poſſeſſions were ſeized by Henry VIII. Few veſtiges of the manſtery now remain; but the church ſtill partly ſubſiſts, and is a noble ſpecimen of ancient architecture. What now remains is but the W. end of the original church, with two lofty towers. The W. entrance conſiſts of an arch with zigzag ornaments, whiſt the towers have the windows in a gradation of different ſtyles of architecture. The interior of the church, in length about 135 feet, conſiſts of a nave and two aiſles; the roof is ſupported by eight pillars, alternately octangular and cylindrical: the ancient pulpit is ſtill preſerved. On the N. ſide of the church are fragments of walls; and foundations are diſcovered in the adjoining meadows: but the moſt curious veſtige of the ancient buildings is a ruinous chapel, at the S.E. corner of the church, now uſed as a place of burial, of which the windows,

ſtill well preſerved, furniſh examples of the lancet form. The gate of the manſtery is nearly entire, and retains a few of the ſtatues with which it was formerly furniſhed. The church and church-yard contain ſome monuments for eminent perſons of former times: one is the tomb of John, brother of Ralph Nevill, the firſt earl of Weſtmoreland, and treaſurer of England. The trade of Worksop, and its appendage Radford, has been much promoted by the Cheſterfield canal, which paſſes cloſe by the N. end of the town. The ſale of liquorice, formerly conſiderable, has been for ſome years at an end, none being now raiſed in the neighbourhood. On the S.W. of the town ſtands the noble manſion of the duke of Norfolk, ſtyled *Worksop-manor*, in the miſt of a park, eight miles in circuit, containing a great variety of ground, and much ancient timber of a fine growth, having once been a part of the great foreſt of Sherwood. The original manſion was erected by the renowned Talbot, the firſt earl of Shrewsbury, on a ſcale of extent and magnificence ſuited to his character and fortune: but in 1761 the whole was unfortunately burnt down; by which accident, the loſs ſuſtained was very great, not only in the furniture, but in the library, the paintings, and the antique ſtatues, part of the celebrated Arundelian collection. Soon after this miſfortune, the duke of Norfolk commenced a new manſion, on a plan of great magnificence, comprising a quadrangle incloſing two courts; but the execution of the ſcheme was interrupted by the unexpected death of the heir of the family. One ſide, however, which is the front, has been finiſhed, and is 318 feet in length, of great elegance and grandeur. In the centre is a portico of ſix Corinthian columns, on a ruſtic baſement. In the tympanum of the pediment is an emblematic representation of the high alliances of the houſe of Norfolk; and on the points are placed three ſtatues. The body of the building is crowned with an open baluſtrade. The interior contains many valuable paintings and portraits of anceſtors and connections of the family. The chapel is adapted to the Roman Catholic ſervice, to which the dukes of Norfolk have always, with the exception of the late duke, been ſteadily attached: it ſerves as a place of worſhip for a number of perſons of the ſame perſuaſion reſiding in the neighbourhood.

At no great diſtance to the S. of Worksop-manor is Welbeck abbey, the ſeat of the duke of Portland. This place belonged to Sweyn the Dane before the Conqueſt. A manſtery is ſuppoſed to have been founded in the reign of Stephen, by Thomas de Cukeneſy, for Premonſtratenſian canons, who were removed from Newhouſe in Leiceſterſhire. In the reign of Edward III., the manor of Cukeneſy was purchaſed by the biſhop of Ely, and beſtowed on the manſtery. At the diſſolution it was purchaſed by a perſon named Whalley, from whom it came to ſir Charles Cavendiſh, youngeſt ſon of ſir William, who married the celebrated counteſs of Shrewsbury. The ſon of ſir Charles, afterwards duke of Newcastle, was the author of a well-known treatiſe on horſemanship. His grand-daughter, marrying John Hollis, duke of Newcastle, left an only daughter and child, who by marriage conveyed the eſtates to the earl of Oxford; and their only child and daughter by marriage transferred Welbeck to the anceſtor of the preſent proprietor. The manſion is a large irregular ſtructure, erected at different periods, containing, particularly within, portions of the ancient monaſtic buildings. The greater part of what is now ſeen was conſtructed about 1604. The interior contains many ſpacious and elegant apartments, which are decorated with a number of portraits of perſons important in English hiſtory.

The grand riding-house and stables were erected by the noted duke in 1623 and 1625: having been long neglected they have been of late years restored, and are now among the most remarkable in the kingdom. Welbeck-park is about eight miles in circuit, and contains noble woods of venerable oaks, some of very great age and extraordinary size. One in particular, noticed in Evelyn's *Silva*, was in his time thirty-three feet round at the bottom, and is conceived to be 700 years old: it is now much decayed. But the most remarkable tree is "the duke's walking-stick," in height about 112 feet; the solid contents are estimated at 440 feet. Near the gate leading to Work-sop is a group of trees, called the "seven sisters," there having been formerly seven stems springing from one root, but one has lately been broken off. The late duke formed an extensive piece of water in the park, and raised a bridge of three spacious arches over it, but which fell down just as it was completed.

About two miles to the eastward of the parks of Work-sop and Welbeck is that of Clumber, a seat of the duke of Newcastle. The mansion is a magnificent stone structure of three fronts, one of which is ornamented with a light Ionic colonnade. The apartments are spacious, particularly the state dining-room, sixty feet in length, thirty-four in breadth, and thirty in height, which is fitted up with great magnificence. In the various rooms are several very valuable paintings. The arrangements for the domestic accommodation of the family are well worthy of notice. The park, now eleven miles in compass, was not long ago a wide tract of forest-land. It is in a manner wholly the creation of the late duke of Newcastle. It now contains about 4000 acres; but half a century ago the ground was little better than a black heath, interspersed with bogs and marshes, through which ran a small stream. The park comprehends, however, two woods of ancient oaks, from one of which the mansion takes its name.

Adjoining to Clumber-park, on the south, is that of Thoresby, the seat of earl Manvers. The old house was destroyed by fire in 1745, after which it was rebuilt by the proprietor, the last duke of Kingston, grandfather of the present possessor. The mansion, which is rather a comfortable residence than a magnificent seat, consists of brick, on a rustic stone basement, with an Ionic portico of four columns in the principal front. The great stair-case, single at the bottom, but divided into two at the first landing, opens into a dome supported by columns, on which rests a gallery, which communicates with the upper chambers. The apartments contain some valuable portraits and paintings. The park is about thirteen miles in circumference, and contains several pieces of water, of which one, near the house, assumes the appearance of an extensive river.—Thoroton's *History of Nottinghamshire*, by Throsby, 3 vols. 4to. London, 1790. *Beauties of England and Wales*, Nottinghamshire, by F. C. Laird, 8vo. London, 1812.

WORLD, *MUNDUS*, the assemblage of parts which compose the universe.

The *duration* of the world is a subject which has been greatly disputed. Plato, after Ocellus Lucanus, held it to be eternal, and to have flowed from God, as rays flow from the sun. Aristotle was much of the same mind: he asserts, that the world was not generated, so as to begin to be a world, which before was none; and, in effect, his whole eighth book of *Phys.* and first book de *Cælo*, are spent in proving the eternity of the world.

He lays down a pre-existing and eternal matter, as a principle; and thence argues the world eternal. His argument amounts to this; that it is impossible an eternal

agent, having an eternal passive subject, should continue long without action.

His opinion was long generally followed; as seeming to be the fittest to end the dispute among so many sects about the first cause.

Epicurus, however, though he makes matter eternal, yet shews the world to be but a new thing, and says it was formed out of a fortuitous concurrence of atoms. See *Lucretius*, lib. v.

Some of the modern philosophers refute the imaginary eternity of the world, by this argument: that, if it be *ab aeterno*, there must have been a generation of individuals, in a continual succession from all eternity; since no cause can be assigned why they should not be generated, *viz.* one from another. Therefore, to consider the origin of things, and the series of causes, we must go back in infinitum, *i. e.* there must have been an infinite number of men, and other individuals, already generated; which subverts the very notion of number. And if the cause which now generates have been produced by an infinite series of causes, how shall an infinite series be finite, to give room for new generations? See *God*.

Dr. Halley suggests a new method of finding the age of the world, from the degree of saltiness of the *ocean*; which see.

It is another popular topic of controversy, whether the world be finite, or infinite? See the arguments on both sides, under *UNIVERSE*.

It is likewise disputed, whether the plurality of worlds be possible? See *PLURALITY*.

Some hold the affirmative, from an opinion of the infinite power of the Deity; it being a setting bounds to omnipotence to say, that he created so many bodies at first, and that he could not create more.

The Cartesians maintain the negative, upon these principles: that it is a contradiction to say, there are several worlds existing at the same time, since this implies several universes of created beings, the world being the *totum*. That if there were several worlds, they must either be at a distance from one another, or contiguous; but neither can be said: for were they contiguous, they would only constitute one; and were they distant, there must be something between. But what can be between? If it be extended, it is corporeal; and, instead of separating the several worlds, it will connect them all into one.

The *existence* of an external world has been much controverted. The arguments on either side, see under *ABSTRACTION*, *BODY*, and *EXISTENCE*.

The world is sometimes divided into *upper* and *lower*: the *lower*, or *sublunary*, is the globe of our *earth* (which see); and the *upper* includes the heavens, and heavenly bodies.

WORLD, *Axis of the*. See *AXIS*.

WORLD, *Map of the*. See *MAP*.

WORLD, *Soul of the*. See *ANIMA Mundi*,

WORLD, *System of the*. See *SYSTEM*.

WORLITZ, in *Geography*, a town of Saxony, in the principality of Anhalt; 5 miles E. of Dessau.

WORM, a river of Norway, which flows from the lake Mioss into the Glom, or Glomen.

WORMDIT. See *WARMSTADT*.

WORMHOUT, a town of France, in the department of the North; 5 miles S. of Bergues.

WORMIA, in *Botany*, a genus of plants first established by Rottböll, was named by him in memory of the famous Danish physician and naturalist, Olaus Wormius, successor

WORMIA.

of Caspar Bartholin in the professorship of medicine at Copenhagen. He died rector of that university in 1654. His Latin writings, on the history and antiquities of Denmark and Norway, are valued for their accuracy. His son William published, in 1655, the *Museum Wormianum*, a handsome work in folio, the second book of which, according to Haller, consists entirely of botanical subjects. Olau Wormius herein describes and figures several rare plants, or monstrous varieties, with a detail of their anatomy. His letters, not published till 1751, are said to contain many things relating to Botany.—“Rottb. Nov. Act. Hafn. for 1783. v. 2. 522. t. 3.” Salisb. Parad. at p. 73. De Cand. Syft. v. 1. 433.—Clafs and order, *Polyandria Pentagynia*. Nat. Ord. *Magnolice*, Juss. *Dilleniaceæ*, De Candolle.

Gen. Ch. *Cal.* Perianth inferior, of five roundish, concave, very obtuse, coriaceous, permanent leaves. *Cor.* Petals five, roundish, concave, larger than the calyx, tapering at the base, deciduous. *Stam.* Filaments very numerous, crowded, short, equal; anthers terminal, linear, longer than the filaments, shorter than the petals, recurved, bursting by a double orifice at the summit. *Pist.* Germens five, or more, superior, distinct, ovate, compressed, crowded; styles terminal, tapering, recurved, longer than the germens; stigmas notched. *Peric.* Capsules as many as the germens, and of the same form, each of one cell and one valve, bursting at the inner edge, crowned with one of the permanent styles. *Seeds* several, from 8 to 12, roundish, “each with a pulpy tunic at the base.” *Salisb.*

Ess. Ch. Calyx inferior, of five coriaceous, permanent leaves. Petals five. Anthers with two terminal pores. Capsules five, compressed, distinct, many-seeded. Styles thread-shaped. Stigmas notched. A genus of trees or shrubs, with rather twining stems, and round smooth branches. *Leaves* alternate, stalked, simple, oval, coriaceous, with a single mid-rib, and many transverse parallel partial ribs. *Stipulas* large, oblong, pointed, deciduous; the young ones convoluted, forming a terminal point, as in the *Magnolia* tribe. *Flower-stalks* about the ends of the branches, opposite to the leaves, angular, either racemose or panicled; often unilateral. *Flowers* white or yellow. *Calyx* remaining coriaceous and dry, not becoming pulpy, in which, as well as the separate stigmas, and elongated styles, this genus differs abundantly from *Dillenia*. (See that article.) M. De Candolle notices the two terminal pores of the anthers in *W. alata*, which he thought might afford a character for dividing the genus, if the same were not found in all the species. We find this character in *W. dentata*, as well as in our new *W. sericea*, and therefore venture to make it a part of the generic distinction.

1. *W. madagascariensis*. Madagascar Wormia. De Cand. n. 1.—“Leaves oval, bluntly sinuated. Clusters panicled.”—Gathered by Commerfon in Madagascar. An elegant tree, with thick round branches. *Stipulas* solitary, large, long, leafy, externally villous, deciduous, each leaving an annular scar on the branch. *Leaves* oval or orbicular, smooth, with broad, obtuse, shallow, marginal notches. *Footstalks* long, channelled above, and marked with transverse wrinkles. *Flower-stalks* nearly opposite to the leaves, erect. *Partial-stalks* single-flowered, without bractæas. *Petals* undulated, thrice as long as the calyx. *Seeds* roundish. *De Candolle*.

2. *W. dentata*. Toothed Wormia. De Cand. n. 2. (*Dillenia dentata*; Thunb. Tr. of Linn. Soc. v. 1. 201. t. 20. Willd. Sp. Pl. v. 2. 1253, excluding Rottböll's synonym. Poir. in Lam. Dict. v. 7. 151.)—Leaves ovate, abrupt, coarsely and rather sharply toothed. Foot-

stalks simple, triangular, smooth. Flower-stalks triangular, from three to six-flowered.—Gathered by Thunberg in Ceylon. We received a specimen, precisely answering to the above plate, in 1786, from professor David Van Royen, marked *Dillenia indica*; *Reaumuria* of Koenig, by whom it was gathered; and *Ghodaparra* of the Cinghalese. This is a tree, with round branches. *Leaves* four inches long, of a broad, elliptic-ovate figure, very abrupt, coriaceous; paler beneath; entire at the base; wavy at the sides; most toothed at the end; transverse ribs very straight. Convoluted *stipula*, at the end of the branch, acute, two-edged, smooth. *Footstalks* linear, narrow, near two inches long, acutely triangular, not bordered, smooth. *Cluster* simple, on a long, smooth, angular stalk, not quite opposite to the uppermost leaf, in our specimen consisting of six flowers, whose partial stalks are about an inch long. Thunberg represents three flowers only, whose petals are obovate, about an inch in length.

3. *W. triquetra*. Triangular Wormia. “Rottb. Nov. Act. Hafn. v. 2. 532. t. 3.” De Cand. n. 3.—Leaves ovate, bluntish, bluntly and slightly sinuated. Footstalks simple, triangular. Flower-stalks triangular, racemose.—Native of Ceylon. *Van Royen*. Described by De Candolle from a dried specimen. “Branches round, brown, smooth, with an elevated ring round the origin of each leaf. *Footstalks* straight, two inches long. *Leaves* oval, or oblong; rather tapering at the base; obtuse, or somewhat pointed, at the end; either entire, or very bluntly and slightly waved; the ribs pinnate, (as in the rest,) having about eight or ten lateral ribs at each side. *Flower-stalks* simple, nearly opposite to the leaves. Two outer calyx-leaves rather the largest. *Petals* concave. *Stamens* very short. *Germens* triangular, crowded. *Styles* reflexed.” Such is De Candolle's description, but he doubts whether this be a distinct species from the last. We have seen neither specimen nor figure, but the plant having been received from professor Van Royen, like our specimen of the preceding, rather confirms the doubt than removes it.

4. *W. alata*. Wing-stalked Wormia. De Cand. n. 4. (*Dillenia alata*; Banks Ic. unpublished, communicated with specimens, in flower and fruit, to Linnæus.)—Leaves oval, entire. Footstalks smooth, winged.—Gathered by sir Joseph Banks, in New Holland, near Endeavour river. The branches are round, smooth, except the annular scars left by the stipulas. *Leaves* three or four inches long, and above half as broad, smooth, obtuse, with distant transverse ribs, and copious reticulated veins; their under surface rusty-coloured, but polished. *Footstalks* an inch or an inch and a half long, winged at each side with an entire leafy border, contracted at the apex, and quite smooth. *Flower-stalk* opposite to the upper leaf of the branch, solitary, racemose, triangular, smooth, shorter than the leaves, bearing two or three yellow flowers, larger than those of *W. dentata*. *Petals* undulated. *Anthers* long, linear, with two pores at the end, like *W. dentata*. *Styles* sometimes nine or ten, recurved. *Capsules* coriaceous, gaping, apparently real follicles, with a number of round seeds, inserted into the margins, destitute, as far as we can see, of any pulpy tunic.

5. *W. sericea*. Silky-stalked Wormia.—Leaves oval, bluntly ferrated. Footstalks depressed, silky, as well as the flower-stalks and calyx.—Native of the East Indies. A specimen in the herbarium of the younger Linnæus, which he supposed to be *Dillenia indica*, is marked “*Mallei Mangajokeri*, a tree with snow-white flowers.” We cannot refer this to any thing in professor De Candolle's work. It undoubtedly belongs to the genus before us. The

branches

branches are round, strongly scarred; when young, finely downy. Leaves crowded about the extremity of each branch, apparently deciduous, being found on young shoots only, shaped like the last, and nearly as large, but somewhat serrated, and, in a young state at least, finely downy; their transverse ribs much more copious, straight, and parallel, than in that. Footstalks half an inch long, stout, broad, and depressed, blunt-edged, not bordered, densely clothed with fine, white, silky, permanent down. Stalks simple, single-flowered, silky, about the length of the footstalks, each opposite to a leaf. Calyx-leaves obovate, concave, an inch long; smooth within; silky at the back. The petals we have not seen. Filaments short. Anthers long, compressed, two-edged, each opening by two terminal orifices. Germens crowded together. Styles five, recurved at the extremity. Stigmas small, abrupt.

We have at the end of the article DILLENIA, hazarded an opinion, that the *D. elliptica*, *integra*, and *retusa* of Thunberg, as well as his *dentata*, above-described, belong to this genus of *Wormia*, to which professor De Candolle seems, by a remark under *D. integra*, in his Syst. v. 1. 437, disposed to agree. Probably he thought it best, having examined no specimens, to leave these plants where he found them, but we cannot omit the following, on the authority of Thunberg's figure.

6. *W. retusa*. Abrupt *Wormia*. (*Dillenia retusa*; Thunb. Tr. of Linn. Soc. v. 1. 200. t. 19. De Cand. Syst. v. 1. 437. Willd. Sp. Pl. v. 2. 1253.)—Leaves obovate, abrupt, distantly toothed, smooth. Footstalks hairy at the base. Stalks single-flowered, smooth.—Native of woods in Ceylon. Thunberg. A tree, apparently nearly related to *W. dentata*, but the flowers are solitary, and rather smaller, each on a simple stalk, opposite to the uppermost leaf. Styles five, evidently those of a *Wormia*, not a *Dillenia*.

WORMING, in *Ship-Building*, windling a rope close along the cuntlines of larger ropes to strengthen them, and make a fair surface for the service. See Plate I. fig. 46. Rigging.

WORMING, in *Animals*, an operation which is sometimes performed on the young of the dog and some other kinds. Young puppies are thus cut, in some cases, under an ignorant supposition that it prevents their going mad; but in reality to cure them, as it generally does, of the disposition to gnaw every thing in their way. It consists in the removal of a small worm-like ligament, situated beneath the tongue; and the part being afterwards sore for some days, the animal is thus weaned of his mischievous habits. See *Diseases of Dogs*.

WORMIUS, OLAUS, in *Biography*, a Danish physician, descended from a family which fled from Arnheim, in Guelderland, to Denmark, from the persecution of the duke of Alva, was born at Aarhus, in Jutland, in 1588, and finished his education at the university of Marburg; afterwards availing himself of the lectures which he attended in the principal German academies, and in his tour through France, Italy, Switzerland, and Holland. He then returned to Denmark in 1610, and having in the following year taken the degree of doctor in medicine at Basle, he passed through the Netherlands to England, and in 1613 returned to his native country, where by successive preferments he became professor of medicine in 1624, in consequence of the resignation of Caspar Bartholin. Although he obtained in 1636 a canonicate in the chapter of Lund, he continued his professional practice, and was often consulted by Christian IV. and Christian V. His knowledge of antiquities, medicine, and anatomy, was profound;

and in 1628 he discovered bones in the human skull, called after his name "sex ossicula Wormiana in futura cranii lamdoidea." His collection of curiosities was, after his death, lodged in the royal museum. He was thrice married, and had 18 children. He died in 1654. His writings were very numerous; and the principal of them are enumerated in the General Biography, to which we refer.

WORMS, in the *Linnaean System of Nature*. See VERMES.

WORMS, in *Husbandry*, are very prejudicial to corn-fields, eating up the roots of the young corn, and destroying great quantities of the crop.

Sea-salt is the best of all things for destroying them. Sea-water is proper to sprinkle on the land where it can be had; where the salt-springs are, their water does as well; and where neither are at hand, a little common or bay salt melted in water does as well.

Soot will destroy them in some lands, but it is not to be depended upon, for it does not always succeed. Some farmers strew on their land a mixture of chalk and lime; and others trust wholly to their winter-fallowing to do it; if this is done in a wet season, when they come up to the surface of the ground, and some nails with sharp heads be driven into the bottom of the plough.

If they are troublesome in gardens, the refuse brine of salted meat will serve the purpose, or some walnut leaves, steeped in a cistern of water for a fortnight or three weeks, will give it such a bitterness that it will be certain poison to them.

A decoction of wood-ashes, sprinkled on the ground, will answer the same purpose; and any particular plant may be secured both from worms and snails by strewing a mixture of lime and ashes about its roots. It is a general caution among the farmers to sow their corn as shallow as they can, where the field is very subject to worms. Mortimer's Husbandry, p. 328.

In the roots of some sorts of garden crops, such as the carrot, onion, shallot, cauliflower, broccoli, and some others, worms and maggots are not unfrequently very injurious and hurtful, unless they be destroyed in sufficient time to prevent such effects. In the first, much advantage is supposed to have been gained by the full use of pigeon dung in preventing the worm.

And in this and the other sorts of garden crops it is found, that much benefit in removing such evils may be produced by a proper succession of cropping, as that of following strawberries which have been four or five years planted with onions, and artichokes that have stood the same length of time with carrots; as these sorts of vermin do not attack either the strawberry or the artichoke. In some cases, it is supposed that it may be safe to crop two or three times with onions or carrots on the same spot, but not oftener, as some appearances of the worm and maggot are generally displayed in the second or third year; but that from the ground being four or five years under strawberries or artichokes, plants on which those vermin cannot subsist, they soon perish, and the land where the rows stood has all the advantage of a new soil.

Soot when applied as a manure is said to be a good preventive of the maggot in onion crops; and that shallots, as requiring only a small spot, may be much improved in growth, and entirely preserved from the maggot, by the application of old hot-bed dung as manure, in the bottoms of the drills, well-mixed with soot; planting the shallots on this mixed manure, and covering them in to a proper depth. The soot in this case prevents the appearance of the maggot, and at the same time greatly improves the strength
of

WORMS.

of the shallot plants: it is a method which has never been found to fail in preventing worms and maggots in such crops.

Cauliflowers, broccoli, and the roots of other such plants, may be preserved from the effects of worms, by watering the drills of them well with soap-suds before planting them out, and afterwards occasionally: this not only, it is said, prevents the worm, but encourages the growth of the plants, and in some measure prepares the ground for other vegetables that are liable to the same sort of attacks.

The maggot is considered by some as peculiar to the onion and shallot, and that whenever the former becomes diseased, it is most liable to its attacks; and that as it could never be detected in the soil, it is highly probable that the ova or eggs of it are deposited in the root, and may be hatched in the greatest numbers when the plants are in a sickly state. It is not supposed, that the maggot ever passes from one onion to another; but that any remedy which is sufficiently powerful to destroy the insect must inevitably destroy the onion itself; that all that can be done is, therefore, to select proper soils and situations for the onion crops.

It is remarked, however, that the maggot which attacks the carrot is unquestionably to be found in the soil, and that it visibly enters from without.

It is concluded on the whole, that worms and insects of these kinds in general are driven from their retreats under ground, by pouring bitter or acrid water upon it, as such in which green walnuts have been steeped, or of which a ley has been made by dissolving potash. See several papers in the first volume of the "Memoirs of the Caledonian Horticultural Society."

WORMS, in Medicine. Three species of worms infest the human body; namely, the *ASCARIS*, *LUMBRICUS*, and the *Tania* or *TAPE-Worm*; which see respectively.

Worms were formerly supposed to be a common cause of a series of morbid symptoms, especially in children; but it is now well understood, that the disease ascribed to their influence is a marasmus depending upon other morbid conditions of the alimentary canal. The symptoms of this disease have been already detailed, under the head of *Diseases of INFANTS*, to which we refer.

Tin is often recommended as a good remedy against worms, particularly of the flat kind. Dr. Alston, in the *Med. Ess. Edinb.* vol. v. art. 7. directs an ounce and a half of the powder of pewter-metal to be mixed in half a Scotch mutchkin, or about half a pint English measure of treacle, for children; but to grown persons, he gives two ounces of the powder of pure tin, passed through the finest hair-sieve, and mixed with eight ounces of treacle. As to the administration of this medicine, the original receipt directs half of it to be taken the Friday before the change of the moon; the day after, half the remainder, and the rest on Sunday. On the Monday, a purge is to be taken. The doctor thinks there is probably nothing in the particularities of the day; but says, the medicine succeeds well in several species of worms.

The efficacy of fern-root against worms was known in the time of Dioscorides; and towards the beginning of this century, Messieurs Andry and Marchant published accounts of successful modes of exhibiting it in these cases. But it has been principally celebrated of late as a specific in the cure of the *tænia*, or tape-worm.

Dr. Priestley, considering how fatal nitrous air is to insects, and likewise its great antiseptic power, conceived that considerable use might be made of it in medicine, in the form of clysters; and he apprehends, that if nitrous air was

diluted with common air, or fixed air, the bowels might bear it better, and that it might still be destructive to worms of all kinds, and be of use to check or correct putrefaction in the intestinal canal, or other parts of the system. Priestley's *Obs. on Air*, vol. i. p. 227.

WORMS, in Animals, a troublesome sort of vermin often found in the intestines of the horse, and some other animals, causing disease. See *BOTTS*, *EARTH-Worms*, *ASCARIDES*, *TÆNIA*, and *TERETES*.

With respect to the cause of worms in horses, it is imagined, that, as in the human subject, some constitutions are more inclinable to breed worms than others. Gibson says, the most usual cause of worms is foul or high feeding, which occasion crudities and slimy indigested matter in the stomach and bowels, (especially in horses that have been pampered for sale,) forming a proper nidus for worms. This indeed may be the case, but the primary cause of worms is that which occasions these crudities, to wit, a want of energy in the functions of the stomach and bowels, as worms are never found in animals perfectly healthy in these respects.

According to Gibson, the signs of worms in horses are various, according to their different kinds. The botts that many horses are troubled with in the beginning of summer are always found sticking to the rectum, and are often thrust out with the dung, along with a yellowish-coloured matter, like melted sulphur. They are no way dangerous there, but they are apt to make a horse restless and uneasy, and rub his breech against the posts. The season of their coming is usually in the months of May and June, after which they are seldom to be seen, and rarely continue in any one horse above a fortnight or three weeks. Those that take possession of the membranous portion of the stomach are extremely dangerous in causing convulsions, and are seldom discovered by any previous signs before they bring a horse into violent agonies. See *BOTTS*.

But the teretes or earth-worms give little disturbance to a horse, and would hardly be discovered, unless they were seen now and then to come away with the dung. Frequently horses void one or two, and no more; and sometimes they will void pretty large quantities of the young brood, not much larger than the ascarides, only of a red colour, and not white, as the latter generally are. They are most usual in autumn, or the beginning of winter, though a horse may now and then void one or two of these at other times of the year.

However, the ascarides, or small needle-like worms, are very troublesome to horses, breed at all times of the year, and often when one brood is destroyed another succeeds. These are not at all dangerous, yet when a horse is pestered in this sort of way, though he will go through his business tolerably well, and sometimes feed heartily, yet he always looks lean and jaded; his hair stares as if he was sickly, and nothing that he eats makes him thrive. That he feels pain, too, is plain, for he often strikes his hind foot against his belly, which shews where his grievance lies, and is sometimes griped, but yet without the very violent symptoms that attend a colic or strangury. He never rolls or tumbles, but only shews uneasiness, and generally lays himself down quietly on his belly for a little while, and then gets up, and begins to feed; but the surest sign is, when a horse voids these worms with his dung.

In regard to the cure, if a horse be troubled with botts, Gibson says, he may be relieved without much expence or trouble, only by giving him a spoonful of favin, cut very small, once or twice every day, in oats or bran moistened; and if three or four cloves of chopped garlic be mixed

WORMS.

with the favin, it will do better, for garlic is of great service in these complaints. Horses that are troubled with bots ought to be purged with calomel and aloetic purges before the weather grows too hot; and if they be kept to a clean diet after this, it will be a great chance if ever they are troubled with them any more. As the bots generally happen about the grass season, those horses that are turned out to grass often get rid of them there, by the first fortnight's purging; and, therefore, those that have the convenience of a good pasture for their horses need not be very solicitous about giving them medicines.

And the earth-worms, which some writers call *teretes*, *rotundi*, or *lumbrici*, are also best conquered by calomel and occasional aloetic purges, for worms often come away in purging, when, till then, it has not been known that the horse was troubled with them; and it has been observed, after these have been voided, that the animal has thriven better, grown more lively, and shewn more alertness at his business. There can scarcely be a better plan of treatment than is supplied in the following *formule*, recommended by Mr. Denny in his useful work:—Take of calomel, one drachm; aniseeds, in powder, half an ounce; treacle, enough to make a ball. This is directed to be given in the evening; and the next morning the following:—Take of succotrine aloes, in powder, one ounce; ginger, in powder, two drachms; treacle, enough to make a ball: and the above bolus and purgative ball must be repeated, with an interval of nine days, until the horse has taken three doses. Then it is advised to give the following alterative powder, daily for about a month; this process does not require any change of diet, or involve any hazard from the effects of cold:—Take of Ethiops mineral, crude antimony, prepared, and aniseeds in powder, each half an ounce; mix them. The management of the horse during this course of worm medicines is that in common cases of physic; but some prefer giving Barbadoes aloes for the removal of worms, thinking it the more efficacious, because its operation is very rough: and Gibson thinks it may be given to hackneys, and other horses of small value; but he never found it more efficacious than the succotrine, at the same time that it exposes a horse more to gripes and other dangerous disorders, unless it be properly managed. The following he gives as a cheap well-corrected purge of this kind:—Take of Barbadoes aloes, one ounce; salt of tartar, two drachms; ginger, grated, a drachm and a half; oil of amber, a middling spoonful; syrup of buckthorn, sufficient to make a ball. The only objection to this is the quantity of aloes, which would be too considerable even if of a milder sort for some horses.

It may be observed, that the sort of worms called ascarides sometimes come away from a horse in great numbers, with the help of a purge, and some get quite clear of them with purges only; but this does not very often happen, for the horses that breed ascarides, above all others, are subject to slime and sourness in their intestines. In the human body, ascarides are thought to be bred in the rectum, near to the fundament; but in horses no other kind than bots usually adhere to that gut. On the contrary, these worms in them seem to be lodged about the beginning of the small intestines near the stomach, where they feed on the alimentary parts of the chyle. The bots in a horse are often seen sticking near the sphincter ani, and are continually dropping away with the dung; but the ascarides are seldom seen there, except when the animal has had a purge given him, or when he falls into a natural purging, which often happens from the irritation of the bowels, and then they come away in very great numbers, accompanied

with much slime and mucus. Bots seldom alter a horse's looks, but these not only make a horse grow lean, and look emaciated, but on opening his mouth one may perceive a more than ordinary languid whiteness, and a sickly smell, instead of that liveliness of colour that is always perceivable in the mouth of a sound and vigorous horse; so that, whatever be the primary cause, these worms seem in a great measure to proceed from a vitiated appetite and a weak digestion, which renders them the more difficult to be removed; for which purpose recourse must be first had to the foregoing remedies, and after them, such medicines as are proper to strengthen the stomach, promote digestion, and give tone to the solids.

The treatment advised by Gibson for these worms is chiefly the following:—Take of calomel, prepared, two drachms; diapente, half an ounce; make these into a ball, with a sufficient quantity of conserve of roses, and give it in the morning, keeping the horse from meat an hour or two before and after the dose; and the next morning administer a moderate aloetic purge, taking great care to keep the horse from wet, or from any thing that may expose him to take cold. The above calomel ball and the purge may be repeated in six or eight days, and again in six or eight days more. Or the following mercurial purge may be given, which will be less troublesome, though not less efficacious:—Take of crude quicksilver, two drachms; Venice turpentine, half an ounce. Rub the quicksilver with the turpentine in a mortar till no particle of the former appear; then add, oil of favin, thirty or forty drops; succotrine aloes, in powder, half an ounce; ginger, grated, one drachm; syrup of buckthorn, enough to make it up into a ball.

One of these mercurial purges may be given in the foregoing manner, *viz.* one in six or eight days, with all the same precautions: it will work mildly, and with little or no griping or sickness. And another mercurial purge, which is proper to destroy worms and to cleanse the first passages, is this:—Take of diagridium, calx of antimony, and calomel, of each two drachms; succotrine aloes, six drachms; ginger, grated, one drachm; oil of favin, cloves, or aniseeds, thirty or forty drops; syrup of buckthorn, enough to form the ball. To be given as the preceding.

When a horse has gone through a course of these mercurial purges, some advise the following drink to be given two or three times a-week, or till the horse begins to thrive and look healthy:—Take of rue, camomile flowers, horehound, of each a handful; galangals, bruised in a mortar, three drachms; liquorice-root, sliced, an ounce. Boil these in a quart or three pints of forge-water fifteen or sixteen minutes in a covered vessel, and keep it covered till cold; then strain it through a piece of coarse canvas, and give it in the morning upon an empty stomach.

Powdered tin has likewise been advised with the intention of destroying worms; and also most of the preparations of antimony: sulphur is also good in all such cases; and even crude antimony in fine powder, given with equal parts of sulphur, often succeeds in the proportion of an ounce in the morning and another at night.

The worms which infest the bodies of other animals of different domestic kinds may be destroyed, expelled, or got rid of, by the same remedies and modes of treatment, only proportioning their quantities to the nature and strength of the animals to which they may be given, and regulating the manner of exhibiting and continuing them, to that of the states in which they may be at the time, from the effects of the worms and other causes.

There is also a kind of worms which are frequently fatal

to the gallinaceous birds, of which a curious account has been given by Mr. Weinfenthal, in the Medical and Physical Journal. The inconvenience produced by these creatures is at first but slight: however, it gradually becomes more and more oppressive, until it ultimately destroys the birds. Very few indeed recover; they languish, grow dispirited, droop, and die. It is found, on dissection, that these symptoms are occasioned by worms in the trachea. The writer has seen the whole of it completely filled with these worms, and has been astonished at the animal's being capable of respiration at all under such circumstances.

They are of a reddish colour, and at first view resemble the human lumbricus; but when examined are materially different. When exposed to the microscope, they are found to have an orifice or mouth at one end, formed for suction; the other end, as far as it can be ascertained, is imperforated. The intestinal tube is much convoluted, like that of the lumbricus.

It does not appear that any effectual remedy has been yet discovered for removing these most destructive animals. They have been drawn out of the trachea by means of a feather, stripped from near its end, which is passed into the larynx and twisted round, till it engages one or two of the worms, which are extracted, but without any relief to the animal, after the operation has been performed.

WORM, in *Timber*, a disease in growing fir, and perhaps other timber-trees, produced by a worm. For which it is supposed by Mr. Nicol, in his "Practical Planter," that there can be no remedy except in the draining and improvement of the soil. Indeed, this disease is not known on soils congenial to the nature of the plant; nor does it ever appear until the tree becomes sickly, by its roots having touched a cankering bottom.

It has been supposed this worm is the same with that which is found in deal, and some other sorts of wood.

WORMS, *Aquatic*. See *Water-Worms infra*.

WORM, *Ascaris*, in the *Linnean System*, a genus of the order of *intestina*, and class of *vermes*; the characters of which are, that the body is round and filiform, and attenuated towards both ends. There are two species. See ASCARIDES.

WORM, *Bee*. See *Generation of BEES*.

WORM, *Butterfly*. See AURELIA, and CATERPILLAR.

WORM, *Canker*. See SCARABÆUS.

WORM, *Chur*. See GRILLUS.

WORM, *Cochineal*. See COCTUS.

WORM, *Connough*, or *Connaught*, in *Natural History*, a name given by the common people of Ireland to a kind of caterpillar found in many parts of that kingdom; and, from its ugly aspect, reputed to be poisonous.

It is said to be the only poisonous creature of that kingdom, and many mischievous effects are attributed to its sting, and to its poisonous quality, when eaten by cattle. As to the first of these opinions, it is evidently erroneous; the creature having no power to sting at all. The other is not so easily proved false, but is much to be suspected. The reasons on which it is founded are these: the cattle in Ireland are subject to a very terrible disease, which is most frequent in autumn; about the time when these animals are in the greatest plenty.

It is most frequent also among those cattle which feed in low and marshy grounds, where this creature lives and feeds; cows and hogs, which feed in these places, are the only creatures subject to the distemper, and this is imputed to the cow's eating by large mouthfuls, because she chews the cud a second time; and the hogs feeding so foul and greedily, as to eat things which other creatures refuse. Finally, the

great cause of assigning this disease to this creature is, that the worm only appears in great numbers about once in seven years; and in these, and these years only it is, that the distemper among the cattle is common.

The symptoms by which this disease is distinguished from all others are, great swelling of the head, and a falling down of the anus; the gut often hanging out to the length of six or seven inches. The common cure among the more intelligent people is a strong decoction of the plant called bear's-foot, or great black hellebore, with some rue and garlic given with butter and beer; this is found to have great success with the cows. The hogs are cured only by mixing redde, or the common red ochre powdered, with butter-milk, and making them eat a large quantity of it.

The Irish peasants have recourse to many idle remedies; but these are found often of real service. The caterpillar, supposed to occasion this disease, feeds on the common ragwort, and is larger than most other creatures of this kind, being of the length and thickness of a man's finger; it is marked with two large spots behind the head, which are supposed by the vulgar to be the eyes, but are only round variegations, of the nature of those common on other caterpillars; and what they take to be a sting in the tail, is no other than a horn in that part, which is not peculiar to this caterpillar, but found on many others. That the common people are deceived in regard to the external parts of this creature is evident; but experiments are required yet to prove whether or not they are so, in regard to its poisonous quality.

One trial is remarked by Mr. Molyneux to have been made on a dog, who eating the skin of only one of the creatures was found dead about three days after; another dog, which drank the juices expressed from that skin, received no hurt. The insect is described in Lister's edition, under the name of the elephant caterpillar. Phil. Trans. N^o 168. p. 880.

WORM, *Earth, lumbricus*, a genus of the order of *intestina*, including two species. See EARTH-Worm and LUMBRICUS.

WORM, *Flower-root*. See FLOWER.

WORM, *Fly*, in *Natural History*, the worm or maggot produced of the egg of a fly, and afterwards to be transformed into one.

These worms are to the fly, what the caterpillar is to the butterfly it produces. The custom of the world has appropriated the term caterpillar to that one species of the flying insects' first state; but we have unfortunately no term of distinction yet established for any of the first state of any of the other flying insects, the creature produced by the egg of the fly scarce being indeterminately called worm. Till more expressive names shall be invented for these, it may not be improper to distinguish those of the different classes by the additional name of the insect they are to be changed into, and to call that which is to become a beetle, the *scarab-worm*; that which is to be hereafter a fly, the *fly-worm*; and so of the rest.

Those which are to be hereafter winged creatures of the fly-class are extremely different one from another in form and figure, and may very properly be arranged into several classes.

The most remarkable and striking differences between the classes of those creatures, are those of the form and shape of their heads. Many of them have heads which it is not easy to distinguish to be such, as they carry no one mark of the head of an animal visibly about them. There are many whose heads are variable at the pleasure of the creature, and which at times are seen to be more or less long, more or less thick, more or less flat, more or less shortened at pleasure

by the animal, and easily bent and turned about in any direction. The heads of these creatures are composed of a very soft and flexible flesh.

There are others whose heads are hard, and which always retain the same regular figure. The first general arrangement of these worms may be into those which have a variable, and those which have an invariable head. The subordinate distinctions may be deduced from the number, disposition, structure, and form of the other parts. Some worms of this kind have no legs; those of others are membranous or scaly; and others have them both membranous and scaly. Some worms have the power of altering the figures of their bodies at pleasure, both as to length and bulk: the bodies of others are rigid, and incapable of these changes. Some, again, have a thin membranous coat; whereas that of others is firm and scaly, or crustaceous. Moreover, considerable differences are observable with regard to the position, number, and figure, of their organs of respiration.

Among the fly-worms of variable heads, the disposition of the stigmata, or air-holes, at which the tracheæ of these animals terminate, will afford several distinctions of genera: *e. gr.* the worms of the common flesh-fly has in its stigmata six apertures, three in each, resembling button-holes; but the worms of many other flies have only one small eminence in each: others have them cylindrical and hollow, and projecting like horns, of which some have two, and others three, differently situated and disposed. The number and figure of the hooks, which serve these creatures for teeth, may also serve for matter of distinction. The common worm of the flesh-fly has two hooks, with a dart between them; others have hooks without a dart; some have one hook, and others none. The figure of the body, and the differences of size and colour, may furnish farther distinctions with regard to the genera of the first class.

Those of the second class, which have variable heads, and differ from the former in having legs like those of the caterpillar class, have often a sort of hooks fastened to them: they have also a long fleshy tail, capable of being lengthened or contracted at pleasure, and resembling the tail of a rat; whence these are called *rat-tailed worms*. In these worms, the tail is the principal organ of respiration; its end being always open, and supplying the office of the stigmata of the other genera.

The fly-worms of the third class, which have invariable heads, and have nothing analogous to the organization of moveable jaws, have pointed heads, or such as seem truncated, and no scaly legs: these form a very numerous family both in the terrestrial and aquatic kingdom, and all of them furnish two-winged flies. Under this class Reaumur enumerates and describes eight genera. This ingenious writer mentions worms of another class, which usually produce four-winged flies, having heads of an invariable figure, and two teeth or moveable jaws near the aperture of the mouth, without scaly legs, and with the stigmata placed on the sides of their bodies. The flies produced from these are, the bees, wasps, ichneumons, gall-flies, &c. There is another class of the hexapode, or six-legged worms, which are transformed into some species of the libellæ; which have no mouth, but two openings at the top of their antennæ, through which their aliment may pass. The *formica leo*, and the puceron eaters, belong to this class. There is another class, which have bodies like those of the caterpillar class, and six legs, besides two other shorter legs or hooks near their hinder part, which serve for motion and for fixing themselves. The water-worms, which make for themselves cases of different materials, and are transformed into papi-

lionaceous flies, are of this class. There is also a class of worms, called false or bastard caterpillars. See FAUSSE *Chenille*. See the more particular description of these classes, and their subordinate genera, in Reaumur's Hist. Inf. tom. iv. p. 161, &c.

WORM, *Gourd*, the name of a species of *tenia*, or tape-worm; the body of which is of an oblong form, flat on the belly, and rounded on the back; its skin is soft, and its mouth large, horizontal, and emarginated, or dented in the middle. It resembles the common gourd in figure, and from thence has got this name of *vermis cucurbitinus*, or the gourd-worm. It is frequently found in the intestines of animals.

WORM, *Golden*. See APHRODITA.

WORM, *Guinea*, or *Hair-WORM*. See CHÆTIA, AMPHIBÆNA, and DRACUNCULI.

WORM, *Gally*, *Glow*, *Gnat*, *Gooseberry*, *Hay*, *Horse*, *Lysimachia*, *Mushroom*, *Oyster*, *Pile*, *Sheep-nose*, *Silk*, *Solitary*, and *Truffle*. See the respective articles.

WORMS, *Meal*. There are two very different insects found in our meal or flour; the one is so small, that it is only to be seen by the microscope; all that the naked eye can discover of it is, that something is alive in the place, from the whole substance of the flour being in motion. See FLOUR.

The other meal-worm is larger, and more frequently offers itself to our observation: it consists of eleven rings, and has three pair of legs. The mouth of this worm is made into a kind of forceps, and from this arise, on each side, a great number of small spinulæ; these serve instead of teeth, and the animal feeds by means of them. They are found sometimes very soft and tender, sometimes hard and firm; at some seasons they are very brisk and lively, at others they have scarce any life in them.

The most remarkable thing in regard to these worms is, that they are always exactly of the colour of the flour which they live among. Ray has observed, that the white flour breeds white ones; the coarser flour breeds larger and greyer ones; and that flour which has the bran among it, breeds brown ones of the same colour with that of itself. This is a provision of nature for the safety of the animal, since were it of a colour different from that of the flour, it must be easily discovered among it, and would be picked out and thrown away. The caterpillar tribe are thus preserved, by being of the colour of the leaves they feed on; their green usually suiting itself exactly to that of the tree or plant. Deslandes, Trait. Physf.

WORMS of the *Sea*. The sea-worms are of the number of those animals which, with the oyster and several other shell-fish, furnish us an instance of animals which remain all their lives fixed in the manner of plants to one spot, whence there is no probability of their moving themselves.

These worms are included in a sort of cases or pipes, and may be divided into two classes, according to the nature of those cases. In the one species these only are made of grains of sand, fragments of shells, and the like, fastened together by a viscous humour; and in the other they are composed of a true shelly matter.

Those worms which have shelly cases are fixed sometimes to the sand at the bottom of the sea, sometimes to stones, or sea substances, and sometimes to the shells of other fishes; their shells are rounded, and, in some degree, conic, as they always gradually grow wider from their point or apex to the mouth; as to the rest, their shape is different in almost every individual, forming divers irregular curves, and often resembling the shapes into which a common earth-worm curls and twits itself in its various motions.

When we consider the effects of the glutinous juice issuing from the body of this animal, in fastening together any loose substances it meets with, so as to form a case for it, it may be easily supposed that the adhesion of the balani-marini, and other the like shells, which remain all their lives fixed to some one spot, is performed in the same manner. Mem. Acad. Par. 1711. See VERMICULUS.

WORMS, Water. Of these there are some which transform themselves by a singular process, without any visible change in its exterior form, into flies, and belong to the third class of fly-worms. They are particularly described by M. Reaumur, Hist. Inf. tom. iv. p. 310, &c.

There is a singular species of these creatures, which is found to be capable of reproduction or multiplication from cuttings, in the manner of the polype.

The discovery Mr. Trembley made of this strange property in the polype, gave occasion to the trying of the experiment in regard to some other insects. Worms were the most natural objects of these experiments; and though they failed in many species, they yet succeeded in some, and proved, that nature has not given that amazing property of reproduction of its most essential parts, to only one species of animals.

Mr. Bonet tried the experiment on a very nimble kind of water-worm, by cutting it into two in the middle, and the success perfectly answered the expectation; for the two pieces continued alive and vigorous, and in a little time became two complete worms. The structure of these worms, though it appear simple to the naked eye, is very worthy the examination of the microscope, and when viewed with this assistance, there are discovered in it parts extremely deserving our attention. Phil. Transf. N° 469. p. 470.

Dr. Hales, in his Vegetable Statics, relates a curious experiment, by which it is proved that the bones of animals, when they are ossified to a certain degree, do not grow any longer, except at their extremities; and the case is the same in regard to these worms; for the old piece, which is the middle of the animal, never lengthens itself, but the addition of new rings to each end makes the increase of length in the worm.

In all these pieces the liquor, which serves as blood to the animal, is found circulating from the tail-part towards the head, in the usual way; and by this motion of the blood it is always easy to know, even in the smallest pieces, which is the head and which the tail-end, and the new head and tail are always seen to come regularly from the proper ends. Phil. Transf. N° 469. p. 470, &c. See REPRODUCTION.

WORM, in Chemistry, denotes a long, winding pewter-pipe, which distillers and apothecaries place in a tub of water, to cool and condense the vapour in the distillation of spirits.

This the chemists also call a *serpentine*. Formerly, this worm, or something like it, was placed above the head of the still, with a refrigeratory at the upper end of it, which is useful enough in the distilling of spirit of wine.

WORM, in Gunnery, is a single or double-wired iron screw, mounted on a wooden handle by means of a socket, or fixed on the end of a rammer, to pull out the wad of a cannon, firelock, carabine, or pistol; it is the same with the *wad-book*, only the one is more proper for small fire-arms, and the other for cannon.

This instrument serves to draw out the wadding, or pieces of cartridges, which remain in the gun after frequent firing, and which would otherwise accumulate so much, that other cartridges could not be rammed home enough to reach the priming, whereby the gun would miss fire.

To **WORM a Cable or Hawser,** in *Sea Language*, signifies to strengthen it, by winding a small line, or rope, all along between the strands.

WORM-Powders. See POWDER.

WORM-Seed, Semen Contra, Semen Sanctum, or Semen Santonicum, is a hot, bitter, drying kind of seed, proper to destroy worms generated in a human body, and particularly in children.

This seed is light, small, oval, composed of a number of thin membranous coats, of a yellowish-green or brownish colour, easily friable on being rubbed between the fingers into a fine chaffy kind of substance, a bitter taste, and a strong smell. It must be chosen new, greenish, of a sharp, bitter, aromatic taste, not a little disagreeable.

The place where it is produced is Persia, about the frontiers of Muscovy. It is brought to us from Aleppo, &c. Naturalists have not been agreed about the plant that produces it.

J. Bauhine has a large dissertation on the subject. Some will have it the species of absinthium, or wormwood, called *santonicum*, or *marinum absinthium*; others will have it the *tanacetum*; others the *abrotanum*; but it is now supposed to be the produce of a species of *artemisia*, resembling in its general appearance our fine-leaved mugwort, called by Linnæus *artemisia santonica*, and the *artemisia austriaca* of Jacquin.

M. Tournefort gives us the following account of this notable drug, in the second volume of his Travels. The fementine, or worm-powder, is not gathered like our seeds. The plant grows in the meadows, and must be let ripen; and the mischief is, that as it grows near to maturity, the wind scatters a good part of it among the grass, where it is lost; and this makes it so dear.

As they dare not touch it with the hand, for fear of making it spoil the sooner, when they would gather what is left in the ear, they have recourse to this expedient. They take two hand-baskets, and, walking along the meadows, sweep the baskets, the one from right to left, the other from left to right, as if they were mowing; by this means the seed is shaken out into the baskets.

These seeds have been chiefly recommended as anthelmintics, and commonly taken, in this intention, either along with molasses, or candied with sugar. For other purposes they appear to be a strong bitter. They give out their virtue both to water and spirit. The extract made by rectified spirits, appears to be the most eligible preparation of the santonicum for the purposes of an anthelmintic; and the watery extract, or a tincture drawn from it, for the more general intentions of bitter medicines.

Some have ascribed their quality of destroying worms solely to their bitterness; but it appears from Baglini, that worms (*lumbri*) immersed in a strong infusion of these seeds were killed in five, and according to Redi seven or eight hours; while in the infusion of wormwood, and in that of agaric, the worms continued to live more than thirty hours; and hence it has been inferred, that their vermifuge effects would not wholly depend upon the bitterness of this seed. To adults, the dose in substance is from one to two drachms in a day. (Woodville's Med. Bot.) The worm-seeds of former pharmacopœias are now properly rejected, as their place is supplied by anthelmintics of more certain efficacy.

WORM-Tincture, in *Chemistry*, a name given by many to a medicine prepared by Hoffmann from earth-worms; and in many parts of Germany esteemed one of the most noted medicines in the world, though less known in other places.

The preparation is this: the worms are to be collected in the spring or summer months, and the larger sort are the best. They are to be carefully dried, and reduced to a fine powder; this powder is to be mixed up into the consistence of a poultice, with oil of tartar *per deliquium*, and this is to stand twenty-four hours; then spirit of wine is to be poured on it, so as to reach three fingers-breadth above it, and a drachm of saffron, and half a drachm of castor, are to be added, and the whole is to stand three days in infusion, and after this be filtered off for use. Some add a small quantity of opium to the tincture, but as it is often wanted in cases where opium is not proper, it is better to keep it separate thus made; and when there is occasion to have it opiated, to add as many drops of laudanum as is judged necessary.

The oil of tartar in this case penetrates the very innermost structure of the worms, and is a means of extracting such a tincture from them, as no art could otherwise contrive to make; and the medicine becomes, according to Hoffmann, much more than an anodyne, from the admixture of the salt of tartar in the tincture.

When it is intended to be made with opium, it is always proper to add also some of the hound's-tongue root, which is found as an anodyne to emulate the virtues of opium.

This tincture, whichever way prepared, is excellent in abating the pains of diseases that do not admit a cure. The fits of the gout are rendered easier by every dose of it; and even in cancers, the pain is quieted in a wonderful manner by it, and life rendered much more supportable. Hoffmann's Act. Laborator. Chym.

WORMS, in *Geography*, late a bishopric of Germany, in the circle of the Upper Rhine, surrounded by the Lower Palatinate, the county of Katzenelnbogen, and the electorate of Mentz; about ten miles in length along the borders of the Rhine. In ancient times, the Vangiones inhabited this district. In the middle ages it was called "Wormbvfeld," "Wormatzfeld," or "Wormsergau;" and one of the bishops, named Victor, is said to have assisted at a council at Cologne, in the year 347. Of the ancient bishops here, however, we have little certainty. The series of the prelates of Worms, which may be most depended on, begins with Erembert, who was appointed bishop thereof about the year 770. The bishop of Worms was subject to the archbishopric of Mentz. In the circle of the Upper Rhine, he was the summoning prince and director. In the council of the princes of the empire, he exchanged place on the spiritual bench with the elector of Wurzburg. The whole of the bishopric situated on the left side of the Rhine is annexed to France, and included in the department of Mont Tonnerre.

WORMS, a town of France, in the department of Mont Tonnerre, late an imperial city of Germany, in the circle of the Upper Rhine, and capital of a bishopric of the same name, anciently the capital of the Vangiones. It was situated nearly in the centre of the diocese to which it gave name, not far from the Rhine, and near the place where the Eisbach and Gießenbach fall into it. This city was accounted one of the free Lutheran imperial cities, with toleration and freedom of worship to the Catholics. The Calvinists had also a church here. To the Catholics belonged not only the cathedral, but likewise four collegiate and the like number of parish churches in or near the city, a college, a gymnasium, three convents, and three nunneries. The bishop's palace here was built quite new, in 1719, at the expense of bishop Francis Louis. The kings of the Franks appointed counts and dukes over it. From time immemorial it has been termed a free imperial city, and is so styled in some records of the emperor Charles IV.,

bearing date in 1355 and 1356, and in the register of the cities of 1386, and was also acknowledged such in 1479, in the diet at Nuremberg; and by the emperor Maximilian I., in formal instruments of 1507 and 1508. In 1495, 1521, 1545, and 1578, diets were held here, and this was the place in which the reformation began in 1525. In 1743, a treaty was concluded here betwixt his Britannic majesty, the queen of Hungary, and the king of Sardinia. In the beginning of the revolution, Worms surrendered to a detachment of the French republican army, and was laid under a heavy contribution by Custine, but evacuated after the loss of Mentz. It was again taken in 1794; 25 miles S. of Mentz. N. lat. 49° 36'. E. long. 8° 22'.

WORMS. See BORMIO.

WORMS's Head, or *Penrhyn Gwyr*, a rock on the south coast of Wales, in the county of Glamorgan. N. lat. 51° 36'. W. long. 4° 17'.

WORMSDORF, a town of Saxony, in the circle of Leipzig; 20 miles E. of Leipzig. N. lat. 51° 16'. E. long. 12° 53'.

WORMSER JOCH, a mountain of the Tyrolse, between the sources of the Adige and the Adda; 8 miles S. of Glurentz.

WORMVILLE, a town of United America, in the Mississippi territory.

WORMWOOD, ABSINTHIUM, in *Botany*. See ARTEMISIA *Absinthium*.

The common wormwood, *artemisia absinthium* of Linnæus, grows wild about dunghills, and on dry waste grounds, flowers in June or July, and may be propagated by slips in March or October, or raised from seeds sown soon after they are ripe. The leaves have a strong offensive smell, and a very bitter nauseous taste; the flowers are equally bitter, but less nauseous; the roots are warm and aromatic, without the bitterness and offensiveness of the other parts: the leaves lose part of their ill smell by being dried and kept for some time. The active parts of this plant seem to be extractive, essential oil, and a small portion of resin.

Wormwood leaves give out nearly the whole of their smell and taste both to aqueous and spirituous menstrua; the former, prepared without heat, being the least ungrateful. Rectified spirit elevates little from this plant in distillation; water brings over nearly the whole of its smell and flavour. Along with the aqueous fluid there arises an essential oil, which smells strongly, and tastes nauseously of the wormwood, though not bitter. The oil drawn from the fresh herb is commonly of a dark green; from the dry, of a deep yellowish-brown colour. The quantity of oil varies according to the season and soil in which the wormwood is produced: in some years, ten pounds have afforded upwards of two ounces; in others, twenty pounds have yielded little more than one ounce. Geoffroy observes (Mem. Acad. Par. 1721), that in rainy seasons and moist soils, it yields the most oil; that in dry years the oil is accompanied with a resinous matter, and proves of a fine green colour; and that in wet seasons it is less resinous, and not green. A decoction of wormwood in water, long boiled, and inspissated to the consistence of an extract, loses the smell and flavour of the plant, but retains its bitterness. An extract, made with rectified spirit, contains, along with the bitter, nearly the whole of the nauseous part; the watery extract gives out its simple bitterness, not only to water again, but to rectified spirit.

Wormwood is a moderately warm stomachic and corroborant: for these intentions it was formerly in common use, but it has now given place to bitters of a less ungrateful kind. An infusion of the leaves, with the addition of fixed

WORMWOOD.

alkaline salt, is a powerful diuretic in dropical cafes. The essential oil is sometimes given, in doses of a drop or two, properly diluted by solution in spirit of wine, as a mild antispasmodic. Its more frequent use is a vermifuge; for which purpose it is both applied to the belly, and taken in pills made with crumb of bread. Dr. Lewis, however, says, that the spirituous extract promises to be, in this intention, preferable to the pure oil; as it contains, along with the oil, all the bitter matter of the wormwood. This plant very powerfully resists putrefaction, and is made a principal ingredient in antiseptic fomentations. Boerhaave commends, in tertian agues, a medicated liquor, prepared by grinding about seven grains of the oil with a drachm of sugar, and two drachms of the alkaline salt extracted from the ashes of wormwood, and afterwards dissolving the compound in six ounces of the distilled water of the plant. Two hours before the fit is expected, the patient is to bathe his feet and legs in warm water, and then drink half an ounce of the liquor every quarter of an hour, till the two hours are expired: by this means, he says, cafes of this kind are generally cured with ease and safety, provided there is no feirrhosity or suppuration.

Dr. Lewis observes, that this medicine is a very serviceable aperient, where obstructions of the viscera prohibit the immediate use of the bark, and in such obstructions as the imprudent use of the bark may have occasioned. Its virtues, he says, might be improved by an addition of the bitter watery extract; though the compound, thus laboriously prepared, would not be at all superior to a simple infusion of the plant in pure water, impregnated with a due proportion of fixed alkaline salt.

The roots of wormwood, says Dr. Lewis, promise to be applicable to some useful purposes: their virtue resides chiefly in the cortical part; and rectified spirit extracts their flavour more perfectly than watery liquors. The Edinburgh college directs a tincture of the dried flowering tops of wormwood, in the proportion of six ounces to a quart of rectified spirit, under the title of *tinctura absinthii*. This, in the opinion of Dr. Cullen, is a light and agreeable bitter, and at the same time a strong impregnation of the wormwood. Dr. Cullen concurs with Bergius and Gladitsch in ascribing to the odour of wormwood a quality of occasioning some confusion of the head; and formerly, he says, when it was the fashion with some people in the country to drink purl, that is, ale in which wormwood is infused, it was commonly alleged to be more intoxicating than other ales. This effect he inclines to attribute to its narcotic power; and he is of opinion, that there is in every bitter, when largely employed, a power of destroying the sensibility and irritability of the nervous power. The dose in substance may be ℥j to ℥ij, and of the infusion, made by macerating ℥vj of the plant in f̄xxij of water, f̄j to f̄xxij three or four times a day. Lewis's Mat. Med. Woodville's Med. Bot.

The ashes of wormwood afford a more pure alkaline salt than most other vegetables, excepting bean-stalks, broom, and the larger trees. In the Amcen. Acad. vol. ii. p. 160. Linnæus mentions two cafes, in which an essence, prepared from this plant, and taken for a considerable time, prevented the formation of stones in the kidneys or bladder; the patients forbearing the use of wine and acids.

Many nauseous insects are destroyed or driven away by the smell of this plant; and it is no uncommon practice among the good women in the country, to preserve their clothes from moths, by laying bundles of dried wormwood among them.

Some of our brewers have a method of using wormwood instead of the hops, to give the bitter taste to their malt-liquors, and to preserve them. It is found to answer the latter purpose very well; but the taste is so disagreeable, that it is much complained of. The reason of this is, that the people who use it do not understand the time of gathering it.

All plants are fullest of juice while in the shoot, but fullest of virtue when they have their seeds on them. This is the case with wormwood, as well as a thousand others; and though, in the feeding-time, it produces much more flavour than when younger, yet it is without that nauseous bitter of the crude juice, which gives us the distaste to the plant.

Some people have found the proper way of managing wormwood; and have given a flavour with it to their malt-liquors, even preferable, in the opinion of all palates, to that given in the common way by hops.

The method is this: the plant is to be gathered when fully ripe, and the seeds upon it, and in this state hung up in small bunches to dry. When thoroughly dried, a certain quantity of good strong malt-liquor is to be impregnated with it, to the utmost strength that it can possibly give it. This is to be set by for use, to add to all the rest.

When the hops should in the common way be added to the beer, this liquor is to be added in a proper quantity, making the taste the judge when there is enough of it.

By this means just what degree of bitter is required may be given to the liquor, and the bitter of this common plant, thus managed, is as perfectly agreeable as that of any vegetable in the world.

The wormwood, for this purpose, should have its seeds carefully preserved in the drying, and it is best if not used till the year after it was gathered. Phil. Transf. N° 124.

The essential salt of wormwood is afforded in great quantity, and possesses in many respects the virtues of the plant. It does not differ from other vegetable fixed alkalies, provided they be equally pure.

Wormwood shares with all other bitters the virtues of an absterfive deobstruent, and is in some degree purgative, as all bitters are. Wormwood is one of those plants which the chemists have generally chosen for their processes of the resuscitation of plants from their ashes; and though the pretended principles of this art are false, yet there have been some of the artists so cunning as to form representations of this plant, that have deceived and puzzled the greatest unbelievers, though they have not convinced them. Phil. Transf. N° 74.

WORMWOOD, *Sea*, *artemisia maritima* of Linnæus, falsely called in our markets *Roman wormwood*, and substituted for it: it is a native of Britain, and grows plentifully about our salt-marshes, and in several parts on the sea-coast, flowering in August and September. In taste and smell it is less unpleasant than the common wormwood; and hence is preferred by the college as an ingredient in some of the distilled waters; the essential oil is less ungrateful, and the watery extract less bitter than those of the common sort. The virtues are the same, differing only in degree. It is less effectual as an antiseptic and anthelmintic, but more eligible as a stomachic. A conserve of the tops, made by beating them with thrice their weight of fine sugar, is kept in the shops; but it is now scarcely ever used.

WORMWOOD, *Roman*, *artemisia pontica* of Linnæus, has more numerous, more finely divided, and darker coloured leaves than the former, and is hoary only underneath, whereas that is hoary all over. This is a foreign species, but as hardy and as easily raised as the others. It is considerably

siderably less ungrateful than either of the former species; its smell is weaker, and its bitterness is mixed with a kind of aromatic flavour. This appears to be the most eligible of the three, as a stomachic and corroborant; in which intention a conserve of the tops has been greatly recommended.

WORMWOOD, *Mountain, artemisia glacialis* of Linnæus, is fine-leaved, and covered with a glossy silk-like down. The mountain wormwood of Valais, or *absinthium seriphium montanum candidum* C. B. is covered with a cotton-like down, and the leaves are curled about the edges. Haller informs us, that the first of these plants is frequent in stony grounds on the Alps; and the second by the sides of sandy roads in the territory of Valais, in Switzerland; that the former is bitterish and aromatic, of great estimation among the inhabitants of the Alps, and the common remedy against the intermittent fevers which often rage there, and for exciting the menstrual discharges, checked by the cold; and that the latter has an acrid aromatic smell and taste, without bitterness, and promises, from its sensible qualities, to be a plant of great virtues. They have not yet been introduced into practice in this country. Lewis. See ARTEMISIA.

WORMWOOD-Tree, in *Gardening*. See ARTEMISIA.

WORMWOOD-Fly, in *Natural History*, a very small black fly, found on the stalks of the common wormwood in June and July.

WORMWOOD-Wine, *Vinum Absinthites*. See VINUM, and ABSINTHITES.

WOROFIDOW, in *Geography*, a town of Poland, in the palatinate of Braclaw; 26 miles N.E. of Braclaw.

WORONETZ, a town of Russia, in the government of Orlof, situated upon a river of the same name, near the spot where it falls into the Don, and thus possessing an easy intercourse with the Black sea. It is qualified for becoming a great capital, being placed so as to enjoy the advantages of both warm and cold climates, and holding an intercourse with all parts of the empire. The streets are wide, but not paved. Tallow is a great article of trade here, and also iron. Here is also the most considerable cloth manufactory in Russia, first established by Peter the Great: the gypsy tribe is very prevalent here.

WORPE, a river of Germany, which runs into the Wumme, 7 miles N.E. of Bremen.

WORRAL, in *Zoology*, an animal of the lizard kind, of about four feet long, and eight inches broad, with a forked tongue, which it puts out like a serpent, but without teeth.

It is a harmless animal, and feeds only on large flies, and the smaller species of lizards. It is found in Egypt only during the hottest months, and principally frequents the grottos and caverns in the mountains on the west of the Nile, where it sleeps during the winter season.

It is said to be greatly affected by music; but experiment shews this to be an erroneous opinion. Poccocke's Egypt, vol. i. p. 208.

WORSBOROUGH, in *Geography*, a village of England, in the county of York, with a medicinal spring; 3 miles S. of Barnesley.

WORSE, a river of England, which runs into the Severn, near Bridgenorth.

WORSHIP of God, *Cultus Dei*, amounts to the same with what we otherwise call religion.

This worship consists in paying a due respect, veneration, and homage to the Deity, under a certain expectation of reward. And this internal respect, &c. is to be shewn and

testified by external acts; as prayers, sacrifices, thanksgivings, &c.

The Quietists, and some other mystic divines, set aside not only all use of external worship, but even the consideration of rewards and punishments. Yet, even the heathens had a notion, that God did not require us to serve him for nought: "Dii quamobrem colendi sint," says Cicero, "non intelligo, nullo nec accepto ab illis nec sperato bono."

The school divines divide worship into divers kinds, *viz.* *latria*, that rendered to God; and *idolatria*, that rendered to idols, or images. To which the Romanists add, *dulia*, that rendered to saints; and *hyperdulia*, that to the Virgin.

Some theological writers have observed, that the Greek word *προσκυνησις*, *to worship*, is not descriptive only of the honour which is appropriated to God, but is indifferently used to signify the honour and respect which are paid to superiors of all kinds, in heaven or on earth. Accordingly, they have distinguished between *civil* and *religious* worship.

The general principles upon which the worship of God is considered as an exercise or act of religion, to which its meaning is commonly appropriated, have been already stated under the articles PRAYER and SUNDAY; and it has been illustrated in three different views of it, as private, domestic, and public. To this article we have referred the more particular consideration of public worship, as a duty of indispensable obligation, and of indisputable importance and utility. If the worship of God, says archdeacon Paley, be a duty of religion, public worship is a necessary institution; because without it, the greater part of mankind would exercise no religious worship at all. Besides, assemblies appointed for this purpose afford regularly recurring opportunities for moral and religious instruction to those who would otherwise receive no such instruction. If we advert to fact, it will be found that the general diffusion of religious knowledge among all orders of Christians, in all Protestant, and in most Christian countries, compared with the intellectual condition of barbarous nations, can be ascribed to no other cause than the regular establishment of assemblies for divine worship; in which portions of Scripture are recited and explained, or the principles of Christian erudition are so constantly taught in sermons, incorporated with liturgies, or expressed in extempore prayer, as to imprint, by the very repetition, some knowledge and memory of these subjects upon the most unqualified and careless hearer. If this practice were not observed even by those members of the community who do not so much need the assistance that is indispensable with regard to others, and sanctioned by their presence and example, we may easily foresee how soon religious assemblies would sink into contempt and disuse. This argument meets the only serious apology that can be made for absence from public worship. But even this is a very insufficient apology in another point of view, because public worship is a duty, independently of the effect of example, of universal obligation. Man is a social being; and as such enjoys many blessings which demand public acknowledgment, and is chargeable with many errors and transgressions which he ought publicly to unite with others in confessing, and is exposed to many evils which he should deprecate in common with others who are in the same fallible or mutable state with himself.

"Surely, some will say," as Paley states another objection against public worship, "I may be excused from going to church so long as I pray at home, and have no reason to doubt but that my prayers are as acceptable and efficacious in

in my closet as in a cathedral; still less can I think myself obliged to sit out a tedious sermon, in order to hear what is known already, what is better learnt from books, or suggested by meditation." They, whose qualifications and habits best supply to themselves all the effect of public ordinances, will be the last to prefer this excuse, when they advert to the general consequence of setting up such an exemption, as well as when they consider the turn which is sure to be given in the neighbourhood to their absence from public worship. You stay from church, to employ the sabbath at home in exercises and studies suited to its proper business: your next neighbour stays from church, to spend the seventh day less religiously than he passed any of the six, in a sleepy, stupid rest, or at some rendezvous of drunkenness and debauchery, and yet thinks that he is only imitating you, because you both agree in not going to church. The same consideration should over-rule many small scruples concerning the rigorous propriety of some things, which may be contained in the forms, or admitted into the administration of the public worship of our communion; for it seems impossible, that even "two or three should be gathered together" in any act of social worship, if each one require from the rest an implicit submission to his objections; and if no man will attend upon a religious service, which in any point contradicts his opinion of truth, or falls short of his ideas of perfection.

We may add, that there are other valuable advantages resulting from religious assemblies, that are not immediately designed in the institution, or contemplated by the individuals who compose them; *e. g.* 1. Joining in prayer and praises to their common Creator and governor has a sensible tendency to unite mankind together, and to cherish and enlarge the generous affections. 2. Assemblies for the purpose of divine worship, placing men under impressions, by which they are taught to consider their relation to the Deity, and to contemplate those around them with a view to that relation, force upon their thoughts the natural equality of the human species, and thereby promote humility and condescension in the highest orders of the community, and inspire the lowest with a sense of their rights. Thus, things are made to appear little, by being placed beside what is great. In which manner, superiorities, that occupy the whole field of the imagination, will vanish, or shrink to their proper diminutiveness, when compared with the distance by which even the highest of men are removed from the Supreme Being: and this comparison is naturally introduced by all acts of joint worship. If ever the poor man holds up his head, it is at church: if ever the rich man views him with respect, it is there; and both will be the better, and the public profited, the oftener they meet in a situation in which the consciousness of dignity in the one is tempered and mitigated, and the spirit of the other erected and confirmed. Moreover, the public worship of Christians is a duty of divine appointment. (Matt. xviii. 20. Heb. x. 25.) Independently of these passages of Scripture, a disciple of Christianity will hardly think himself at liberty to dispute a practice set on foot by the inspired preachers of his religion, coeval with its institution, and retained by every sect into which it has been since divided. Paley's *Philos.* vol. ii.

As to the manner in which public worship should be conducted, if we advert to the history of the primitive church, we shall find, that when the congregation was assembled, the first act of divine service which they performed was the reading of the Holy Scriptures. (See Tertullian *de Anima*, c. 3. Justin Martyr, *Apolog.* ii.) When the reading of the Scriptures was ended, then followed the singing of psalms. (See Tertullian, *ubi supra.* Pliny *Epist.* ad Trajan. Clemens Alex. *Stromat.* l. 6. Origen, *De Orat.* § 6.) The

psalms or hymns which were sung by the primitive Christians were either taken out of the Holy Scriptures, and particularly out of the book of Psalms, or such as were of their own private composition. (Tertullian, *Apolog.* c. 39.) As to their manner of singing, it was, says Origen, (*De Orat.* § 6.) in good tune and concert, all the people bearing a part in it. With respect to church-music, organs, and the like, they were not known in the primitive ages to which we now refer; for it cannot be rationally conceived that in those days of continual persecution or violence they could either use or preserve them. The singing of psalms was followed by the preaching of the word. (See Tertullian *de Anima*, c. 3.) The subject of the sermon was usually a commentary or explication of the lessons that had been just before read. (See Just. Martyr, *Apolog.* ii. Origen *contra Celsum*, lib. iii.) As for the length of the sermon, it usually lasted an hour. It began with an exordium, and then explained verse after verse, and sentence after sentence, shewing the natural and literal signification of the words, and then the spiritualized or mystical meaning of them, and concluded with a suitable application of all, either by way of exhortation to piety and virtue, or by way of dehortation from vice and impiety; always accommodating the discourse to the capacities of the hearers. (Origen *contra Celsum*, lib. iii.) The preacher was usually the bishop of the parish. (Just. Martyr, *Apolog.* ii.) Or, the bishop decreed a presbyter, or some other fit person, to preach in his room. When the sermon was finished, the congregation rose up to present their common and public prayers unto Almighty God (Just. Martyr, *Apolog.* ii.); standing being the usual posture of praying, at least the constant one on Sundays, on which days they esteemed it a sin to kneel; and the preacher frequently concluded his sermon with an exhortation to his auditors to stand up and pray to God, which is found to be the case in Origen's sermons. When the congregation stood up, all turned their faces towards the east, which was their usual custom (Tertullian, *Apolog.* c. 16.); for which practice they alleged the following reasons: 1. Respect and reverence to their lord and master Jesus Christ; this being the title given to him in the Old Testament, according to an erroneous translation of the word *branch* in the Septuagint. So that the east was called by Tertullian a type of Christ. 2. The similitude (*Zach.* vi. 12.) of the arising of the sun to our spiritual arising out of the darkness of sin and corruption, as Clem. Alex. expresses it. (*Stromat.* lib. vii.) 3. The advice of Origen to pray towards the eastern climate, as denoting our diligence in the service of God, in being more forward to arise and set about it than the sun is to run its daily course, for which he produces the authority of an Apocryphal text, *Wisdom*, xvi. 28. (Origen *de Orat.* § 20.) 4. The opinion they entertained of the excellence of this quarter above others. (Origen *de Orat.* § 21.) The congregation being thus turned towards the east, they put themselves into a posture of prayer, stretching out their hands, and lifting up their eyes towards heaven. (Clem. Alex. *Stromat.* lib. vii. Tertull. *Apolog.* c. 30.) The minister then began to pray, his usual garb being a pallium, or, as we call it, a cloak; which was deemed a more simple and plain garment than the toga, which was used through the whole Roman empire. But it does not appear from any authority of ancient writers, that they put a surplice or any other kind of linen garment over their cloaks. The prayer was pronounced, as Cyprian says (*De Orat. Domin.* § 2.), with a modest and bashful voice, that being most proper for those who came to acknowledge the multitude and heinousness of their sins, and to beg God's pardon and grace, which is the end and design of prayer. The people did not vocally join with the minister in the prayers,

but satisfied themselves with testifying their assent to what he expressed, by saying Amen, or so be it. Indeed it was impossible for the people to respond, since they had no fixed public form of prayer, except the Lord's prayer, which they frequently, though not always, repeated; and as to their other prayers, every bishop or minister of a parish was left to his own liberty or ability therein. The constant repetition of the Lord's prayer with other prayers was not thought to be necessary, but it was frequently omitted. Accordingly they regarded the Lord's prayer as given by Christ for a pattern of all other prayers, so that Cyprian (*De Unit. Eccles.* § 11.) calls it the law or rule of praying. But though the repetition of the Lord's prayer was not necessary, yet it was usual. Although they used that, they had also other prayers. Their usual method, according to Tertullian (*De Orat.*), seems to have been, first to begin with the Lord's prayer, as the ground and foundation of all others, and then, according to their circumstances and conditions, as he expresses it, to offer up their own prayers and requests. These other prayers, however, were not restricted or imposed forms; but the words and expressions of them were left to the prudence, choice, and judgment of every particular bishop or minister. In other words, the primitive Christians had no stinted liturgies, or imposed forms of prayer. As to prescribed forms, there is not the least mention of them in any of the primitive writings, nor the least word or syllable tending to it, according to lord King, which, as he says, is an unaccountable silence if there ever were such, but rather some expressions intimating the contrary; such as the minister's praying *ὅση δύναμις*, according to his ability. (*Just. Mart. Apolog. ii.* Origen, *Comment. in Matth. et in Johann.*) The noble author now cited has shewn from parallel passages, that the minister's praying *ὅση δύναμις*, or according to the utmost of his ability, imports the exercise of his gifts and parts in suitable matter and apt expressions; and that the primitive prayers were such appears farther from a passage in Origen, which explains the verse in *Matth. vi.* "When ye pray, use not mere repetitions, &c." It is very unlikely, continues his lordship, that they were obliged to prescribed forms, because they never read a syllable of their prayers out of any book whatever; which is evident from their posture of prayer, that was two-fold, either with their hands and eyes lifted up to heaven, or with their eyes shut. (*Tertull. de Orat.* Origen in *Matth. vi. 5.* *De Orat.* § 9. *Contra Celsum*, lib. vii.) If they had used prescribed and imposed forms, they must necessarily have remembered them, which would have been an intolerable load to the strongest memory; especially to have repeated, word after word, the prayers of their fast-days, which must have been several hours long, since some of their fasts were prolonged from the morning of one day to the beginning of another. Whether their prayers were divided into several collects, our author has not been able positively to determine; but he thinks it probable, that on their fast-days they made several distinct prayers, and that at their ordinary meetings, their prayer after sermon was but one entire piece. According to *Just. Martyr (Apolog. ii.)*, the prayer that preceded the confirmation of the eucharistical elements "was one long prayer, to which the people said, Amen." *Lord King's Enquiry into the Constitution, Discipline, Unity, and Worship of the Primitive Church*, part ii. See **LITURGY**.

WORSLEY, in *Geography*, a populous township in the parish of Eccles, and county of Lancaster, England, 6 miles W.N.W. from the town of Manchester. In the year 1811, this place contained 6151 inhabitants, who occupied 1012 houses; and nearly the whole of whom were engaged in manufactures and the coal-mines. At this place is the

famous tunnel for the Bridgewater canal, (see **CANAL**,) and a large brick mansion, called **Worsley-hall**, which belonged to, and was inhabited by, the late duke of Bridgewater. See *Lancashire Gazetteer*, 1808.

WORSTED, or **WORSTED**, a market-town in the hundred of Tunstead, and county of Norfolk, England, is situated 4 miles S.S.E. from North Walsham, and 120 miles N.E. by N. from London. It was formerly a place of much celebrity, and of considerable trade; but is now greatly on the decline, and is chiefly remarkable for the invention, or first twisting, of that sort of woollen yarn or thread, which hence obtained the name of worsted. This manufacture is mentioned in the second year of Edward III. when the weavers and workers of worsted stuffs were required by parliament to work them in a better manner than they had previously done. These stuffs, and knit and wove hose, constitute the chief manufacture of the town. A weekly market is held on Saturdays, and here is an annual fair. The church consists of a nave, two aisles, a chancel, and a square tower. The population of the parish, according to the return of the year 1811, amounted to 619, occupying 112 houses.

Contiguous to the town is **Worsted-hall**, the seat of sir George Berney Brograve, bart., a commodious mansion, situated in a pleasant park.—*Beauties of England and Wales*, vol. xi. Norfolk; by J. Britton, F.S.A. 1809. *Blomefield's History of Norfolk*, vol. xi. 1810.

WORSTED, and **WORSTED Manufacture**. The term worsted is applied to yarn, and manufactured goods made of combed wool. Worsted is properly a branch of the *Woollen Manufacture*, to which article we refer our readers; but the latter term, strictly speaking, is applied only to yarn, or pieces made entirely or in part of carded wool. The characteristic distinction between combing-wool and short or clothing-wool has been already stated under the article **WOOL**. (See **WOOL** and **WOOLLEN Manufacture**.) Worsted goods were made in England as early as the time of Edward II. In the account of exports in the following reign, already given in the article **WOOLLEN Manufacture**, the number of pieces of worsted goods exported is nearly double that of woollen cloths. According to Camden, the name is derived from **Worsted**, a town in Norfolk, where worsted stuffs were first made. According to Dr. Parry, in his "Essay on the Merino Breed of Sheep," worsteds were called by the Flemings '*Ostades*,' and as the manufacture was in their hands long before it was introduced into England, it is probable that our appellation is a corruption of their's. *Ostade* was long ago a common surname in Flanders, and was perhaps that of some person famous for this particular branch of the woollen trade, which afterwards was appropriated to an establishment of similar manufacturers in Norfolk.

Worsted yarn is made of long or combing-wool, in which the fibres are all laid even parallel with each other by the wool-comb. It may be classed into two great divisions, the soft and the hard worsted yarn. The soft yarn is made of the shorter kinds of combing-wool, the sorting of which has been already described under the article **WOOL**. The short and long combing-wools are both prepared for spinning by the comb in the same manner, except that for some kinds of fine hard yarn made from the latter, the wool is combed, and afterwards spun nearly without oil. This is the case with the yarn for bombazines. The soft yarn for hosiery receives but little twist in the spinning, and two, three, or more threads are afterwards twined together on what is called a doubling-mill, to make a thread of requisite strength and thickness to be woven on the stocking-frame. See **STOCKING-Frame**.

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Knitting-yarn is twined much harder than yarn for the frame. For mixed coloured stockings, part of the wool is dyed and mixed with the white in the process of combing. The principal seats of the worsted hosiery manufacture in England were Nottingham and Leicester; but of late years the worsted hosiery has declined at the former place, the trade there being principally confined to silk and cotton articles. Formerly hosiery comprised a variety of worsted articles, particularly caps, which were generally worn in England before the introduction of hats.

At Aberdeen, in Scotland, there is a considerable manufacture of hosiery, the wool being principally supplied from London. Worsteds stockings, and lamb's-wool hosiery, to the amount of from fifty to seventy thousand pounds, are said to have been annually exported from Aberdeen to Holland. Of the number of hands employed in worsted hosiery in England, or the annual value of the goods made, we have no correct account. Perhaps some estimate may be formed from the amount of exports of woollen hosiery given under the head *Woollen Manufacture*, in the table of exports, in which it will be seen, that in the year 1816 the worsted hosiery exported amounted to one hundred and fifty-one thousand and sixty pounds. This, we believe, includes the hosiery made of woollen yarn, or what is generally called lamb's-wool yarn, an article which, since the beginning of the present century, has been greatly increasing in demand. Soft worsted yarn for hosiery, during the last twenty years, has been principally spun and doubled by machines in large worsted-mills. Previously to that time, worsted-making by hand-spinning was a distinct trade from hosiery. The worsted-maker bought his different sorts of combing-wool from the wool-stapler, combed and spun it, and sold the yarn to the hosiery. Since then, the hosiery have been principally supplied with worsted yarn from large mills established in Leicestershire, Nottinghamshire, and Warwickshire. Of late, however, many of the hosiery are manufacturing their own yarn on machines or mules turned by the hand, or in small mills turned by horses or water.

The combing-wools of Kent are better suited for hosiery worsted yarn than any other in England, particularly for machine-spinning. This excellence is derived partly from the softness as well as soundness of the wool; but particularly from the staple being nearly of one uniform thickness from the bottom to the top. See *WOOL*.

Picardy and Normandy were the principal seats of the worsted hosiery in France. Under the article *WOOLLEN Manufacture*, it will be seen that 1,250,000 pounds weight of wool were consumed annually in the manufacture of hosiery in Picardy before the French revolution.

The stocking-frame was invented by William Lee, M.A. of Cambridge, in 1589, and was afterwards introduced into France. This invention took place in England only 28 years after the knitting of hosiery yarn on needles had been introduced from Spain. See *STOCKING-FRAME*.

Hard worsted yarn for worsted stuffs or pieces is spun much smaller, and twined much harder, than the soft worsted yarn for hosiery. In all the stouter kinds of worsted goods, the long or heavy combing-wool is used. (See *WOOL*.) Under the article *WOOLLEN Manufacture* we have noticed the introduction of the worsted trade into England, and various places where it was first established. Norwich and some of the towns in Norfolk and Suffolk appear to have been the first where any considerable quantity of worsted pieces or stuffs were made. The names which the different kinds of worsted pieces have received are very numerous, being often derived from the manufacturer who introduced a slight change either in the mode of weaving or

finishing the goods. These names soon became obsolete, being supplanted by other kinds of worsted goods, so that we do not know at present to what particular kind of pieces some of them were formerly applied; the essential difference consisting in their being woven plain, twilled, or figured, or made with a warp of single or doubled yarn, and woven stouter or more slightly, or of greater or less width, and whether they were glazed or not in the finishing.

The most important distinction between worsted pieces and woollen cloth consists in the former not being milled or raised, so as to cover the surface with a pile, but the thread is left bare. To take off the loose hairs which rise from the surface, the worsted pieces are passed over a red-hot cylinder, in the same manner as many kinds of cotton (see *COTTON Manufacture*): this process is called *fining*. For some particular purposes, a slight degree of milling has recently been attempted to be given to worsted pieces in the fulling-mill. The glazing communicated to some kinds of worsted goods is given by pressing them between sheets of stiff glazed press-paper and heated iron plates, which are compressed in a strong pressing-frame. For the weaving of figured pieces, see *WEAVING*, and *DRAUGHT of Looms*.

Some kinds of very fine worsted goods are made with a warp of mohair or silk, as silk camlets and bombazines. The latter goods, with a silk warp and worsted with hard worsted yarn of the finest kind, are manufactured at Norwich. The term bombazine appears to be derived from bombycina, a kind of silk dress used by the Romans, and said to come from Assyria. It is generally understood to have been made from the threads of an insect called the bombyx. Bombycina is sometimes confounded by commentators with byssinum and sericum. Byssinum appears to have been a very fine kind of linen or lace; sericum unquestionably means filken stuff, so called from the Seres, the nation whence it was procured. Probably bombycina was a coarser kind of silk. In the middle ages, the word bombycina was applied to cotton. Macpherfon's *Annals of Commerce*. See *BYSSUS*.

Bombazines are woven with a twill, and have, as before stated, a warp of silk and a weft of fine worsted yarn. The Dutch refugees, who fled from the persecution of the duke of Alva, introduced the manufacture of this article into Norwich in the year 1675, when the Dutch elders, according to Blomefield, presented bombazines in court at Norwich. (Blomefield's *Hist. of Norfolk*, vol. ii. p. 205.) Worsteds goods were made in Norwich as early as the reign of Edward II. This appears from a patent granted to John Peacock, for the measuring every piece of worsted made in the city of Norwich or county of Norfolk. Norwich has continued from that time one of the principal seats of the worsted and stuff trade. The sale of stuffs made in Norwich only, in the reign of Henry VIII., amounted to 100,000*l.* annually, besides worsted stockings, which were computed at 60,000*l.*

Norwich is at this day the only part of England where any considerable number of the very finest stuffs and bombazines are made. The manufacture of the coarser kinds of worsteds, except camlets, has been transferred in a great measure into Yorkshire. The period preceding the American revolution, from the year 1743 to 1763, may perhaps be regarded as the most flourishing era of the worsted manufactures of Norwich. According to the account of Arthur Young in 1771, the manufactures of this place had increased four-fold in the preceding 70 years. The number of looms was then estimated at 12,000, and each loom was supposed to employ six persons in preparing and finishing the

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the material; and the total annual value of the goods was estimated at above 1,200,000*l.* Of these goods the estimate then was,

	£
The export to Rotterdam - -	480,000
----- to London - -	550,000
----- to various places - -	200,000
Total value -	1,230,000

The number of persons employed being from seventy to eighty thousand.

Since the time to which Arthur Young refers, the manufacturers of Norwich have engaged extensively in the trade of silk shawls and other articles, in which no worsted whatever is used. Still, however, the worsted manufactures of Norwich may be considered as in a flourishing state. The number of looms employed in worsted at the present time (1818) may be estimated at 10,000; half of which weave camlets, calimancoes, and other stuffs; and the other half bombazines, narrow and broad. The former are chiefly for home consumption, the latter for the Spanish market. The East India company take a considerable quantity of the fine camlets manufactured at Norwich.

By far the greatest part of the worsted yarn employed at Norwich is supplied by machine-spinning, from the worsted-mills in Yorkshire, Lancashire, and Durham. But some yarn still continues to be spun in the old manner, by the running-wheel, in Suffolk, Essex, Hertfordshire, and Cambridgeshire. In Norfolk alone, the use of the distaff still remains. This instrument is the most ancient of which we have any notice, either in sacred history, or the fabulous traditions of Grecian mythology handed down to us by Homer and Hesiod. It is at present vulgarly called the rock. In using it, the thread is drawn out from the end of the siver of combed wool. The motion is communicated to a rough kind of spindle, by twirling it between the right-hand and the thigh, which is suffered to continue revolving when suspended by the thread, which the spinstrefs gradually lengthens with her fingers.

In wheel-spinning, a small portion of the combed wool or siver is laid across the finger, from the centre of which, called the twitch, the thread is drawn out. About thirty years since, the counties of Norfolk, Suffolk, Hertfordshire, and Essex, not only supplied all the yarn that was wanting for the manufactures of those districts, but sent large quantities of worsted yarn to Halifax and Manchester. At present the trade is completely turned, and, as we have before stated, the greater part of the yarn used at Norwich is sent there from the northern counties of England. This change has occasioned great distress in the villages where the yarn was formerly spun, by depriving the wives and children of the cottagers of their common employment.

Until the middle of the last century, worsted goods were manufactured in considerable quantities in Warwickshire, Oxfordshire, and Northamptonshire; but about that time the extension of the worsted trade in the West Riding of Yorkshire, particularly at Halifax, Bradford, and Wakefield, gradually drew this trade in a great measure away from those counties. The manufacturers in Yorkshire, or rather the merchants who bought the worsted pieces from the manufacturers, were, however, long unacquainted with the best modes of dyeing and dressing them; they were therefore sent to London or Coventry to be finished, but afterwards they were finished in Yorkshire. The demand to Spain, Portugal, Italy, and the Levant, took off the greater part of the worsted goods manufactured at Halifax;

those manufactured round Wakefield and Bradford, consisting chiefly of tammies and shalloons, were consumed principally by England and her colonies. The Piece-hall at Halifax was first opened about the year 1780; and the intervening time, from thence to the year 1792, or the breaking out of the French war, may be regarded as the most flourishing era of the worsted trade in Yorkshire. Though the cheapness of calicoes, as an article of female dress, since the improvements in the cotton manufacture, materially abridged the sale for some kinds of worsted goods in England, this was more than compensated by the increased demand for carpets with worsted warps, and other articles of luxury, in which worsted yarn was employed.

The demand in foreign markets, from the year 1782 to 1792, for English worsted goods, greatly exceeded that of any former period; but after the breaking out of the French war, the worsted trade at Halifax began to decline. The greater part of the foreign markets being closed against us, most of the mercantile houses engaged in the export of worsted pieces were in consequence ruined or declined; the trade altogether, and many of the small manufacturers, engaging in the cotton trade. The introduction of English calicoes into Turkey and other parts tended also to lessen the regular demand for shalloons and other worsted goods, as articles of female dress, in those countries. Soon after the breaking out of the French war in 1792, the spinning of worsted by machinery was established at Bradford and the vicinity; and continuing to increase, drew round that place the manufacturers of worsted goods on the decline of the Halifax trade. Bradford is now become the principal seat of the worsted manufacture in Yorkshire; and some of the proprietors of the worsted mills, besides supplying the smaller manufacturers with yarn, employ a very great number of looms themselves, and carry on this branch of trade on a scale of extent never before known in the worsted manufacture. Within the last two years, the worsted trade has also greatly revived at Halifax.

The following are the kinds of worsted pieces at present principally made in Yorkshire.

Bombazets are woven both plain and twilled, with the warp of single thread; they were pressed, and finished without glazing: the width 22 inches, length 29 yards.

Tammies, or *durants*, with single warps twilled, and generally coarser than twilled bombazets: width from 32 to 36 inches, length 29 yards.

Shalloons are woven with a twill, and have a warp of single thread. We believe the name was derived from Châlons in France. The pieces are from 32 to 36 inches wide, and 29 yards long.

Cubicas are very fine shalloons so called.

Sayes, or *anascotts*, are twilled and made with single warps; they are of two kinds, one running 27 inches wide and 30 yards in length, the other 42 inches in width and 44 yards in length.

Moreens are woven plain and watered or embossed, and are made very stout, being principally used for furniture: their width is 28 inches, length 24 yards.

Calimancoes are woven plain and striped: width 17 inches, length 29 yards.

Camlets are both plain and twilled: width 18 inches, length 29 yards. They are shorter than bombazets, but not many are made in Yorkshire with doubled warps.

Lastings have doubled warps, sometimes of two and sometimes of three threads, and are made with great variety of patterns, either plain, twilled, or flowered, and are distinguished by different names, according to their figures and quality;

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quality; as prunelle, amens, (probably from Amiens in France, where they were manufactured,) and drawboys: the width 18 inches, length 30 yards.

Worsted shag, or velvet woven like corduroi and cut, is made principally at Banbury, in Oxfordshire, and at Coventry; but has been manufactured also in Yorkshire.

In the worsted manufactures of France, there were greater varieties of pieces than in England. One kind of camlet, made with a fine warp from the wool of the Angora goat and a weft of fine worsted, was remarkably beautiful; but we believe it has not been manufactured in Yorkshire or at Norwich.

For some account of the worsted manufactures of France, see *WOOLLEN Manufacture*; under which article we have given the history of the worsted manufacture as connected with the woollen, and where may be seen the number and value of the worsted pieces exported from England in the year ending January 1817. See also *long combing-wool*, under the article *WOOL*.

WORSTED Spinning. In the article *WOOL* we have given an account of the different kinds of long wool which are proper for spinning into worsted, also the manner of sorting and scouring them. This wool must be prepared for spinning by repeated combings, with a comb or heckle that is provided with a great number of long steel pins which are sharp-pointed. These points being few in number compared with the teeth of cards, they can be safely introduced between and drawn through the long fibres of the wool, in order to separate and straighten them, without materially breaking them. Another object of the combing is, to separate the short fibres which are intermixed with the long ones; for in spinning any kind of thread, it is desirable that the fibres should be all as nearly as possible of a length.

Wool-combing.—In the ordinary process of wool-combing by hand, the implements used are, 1. Two combs for each workman. 2. A post, to which either of the combs can be fixed, to support them during the operation. 3. A comb-pot, which is a small stove to heat the teeth of the combs, which is found to facilitate the combing. The combs are shewn at *fig. 1. Plate I. Woollen Manufacture*: each comb is composed of two rows of pointed steel teeth, *a* and *b*, disposed in two parallel planes. One of the rows contains longer teeth than the other. They are fixed into a wooden stock or head *c*, which is covered with horn, and has a handle *d* fixed into it, perpendicular to the planes of the rows of teeth. The rows of teeth are about seven inches long, and each row contains about twenty-four teeth. The length of the longest teeth is near twelve inches, and the shorter ones about eight inches. The teeth are made of steel, of a round figure, and regularly tapering from the base, where they are fixed into the stock, to the point, which is quite sharp. The teeth are about one-sixth of an inch in diameter at the base; and the interval between the two adjacent teeth at the base is rather less than their diameter, or one-eighth of an inch. The space between the two planes in which the teeth are disposed is about one-third of an inch at the bases of the teeth. The teeth should be straight and well-tempered, and polished. If they become crooked in working, the workman must straighten them, and set them all in a true line. The combs used for the last combing of the wool have three rows of teeth.

In the wool-comber's shop a post is fixed, as shewn by *fig. 2*, in order to support the combs occasionally during the working. An iron stem *g* is fixed fast into the post, and projects horizontally from it; the extreme end of it turns upwards with a point, which is inserted into a hole through the middle of the handle of the

comb. Also at the other end of the stem *g*, close to the post, there is a small hook *b* rivetted, which terminates with a pointed pin, situated in an horizontal direction. This point is inserted into a hole made in the end of the handle of the comb, in the direction of its length. The end of the comb-handle being first placed on the point of the hook *b*, it is let down upon the other point *g*, which, by passing through the handle, fixes the comb quite fast to the post, as shewn at *fig. 2*.

In the operation of combing wool, it is necessary to heat the teeth of the combs, in order to soften and relax the fibres of the wool, and render them more easy to work. The heat also tends to distribute the oil with which the wool is lubricated. The combs are heated in a comb-pot or stove, *fig. 3*, which is a small furnace built in brick, to inclose a fire-place, of which *A* is the door, *B* the ash-pit, and *C* the flue. Above the fire a circular cast-iron plate *aa* is placed. This is made flat, except in the central part, where there is a concavity, to obtain a better action of the fire. Immediately over the plate *a*, another plate, *bb*, is placed parallel to the former, but with a sufficient space between them to admit the teeth of the combs: several pieces of iron are placed between the two plates, to keep them at a proper distance asunder, and to divide the space into small cells proper for the combs.

In using this stove, the workman must be careful not to heat it too much, and a damper in the flue is very useful to regulate the draught; if the heat is too great, it spoils the temper of the comb-teeth, and injures the wool also. The most improved stove is heated by steam, which will give a sufficient warmth, but cannot overheat the combs.

In order to comb the wool, it is separated into handfuls, each containing near four ounces of wool, which is about a proper quantity to be combed at once. These handfuls are sprinkled with oil, and the wool is rolled in the hands to distribute it equally. The quantity of oil varies from $\frac{1}{8}$ th to $\frac{1}{4}$ th of the quantity of wool by weight. The comb is first heated by introducing the teeth into the stove, in one of the cells between the two iron plates; when it has acquired sufficient heat it is withdrawn, and another comb is put in its place. The heated comb is then fastened to the post, with its teeth pointing upwards, in order to be filled with wool; the comber takes one-half of the handful of wool in his hand, and catches it upon the teeth of the comb by throwing the wool over the points, so that they penetrate it; then by drawing the wool towards him, and at the same time downwards to the bottom of the teeth, a portion of the wool will remain in the teeth. The lock of wool is again cast upon the teeth, and drawn through them, and every time some wool remains; this is repeated as often as is necessary, until all the wool is gathered upon the teeth. The comb thus filled is placed with its points in the stove, and the wool which is upon it remains outside of the stove, but will become slightly warmed. The other comb, which was heating whilst the first was filling, is now filled in turn, in the same manner as the first, and is then put to heat with the wool upon it, and whilst this is going on, the workman occupies himself in making a handful ready for the next combing.

When both combs are properly warmed, the comber holds one of them with his left-hand over his knee, as he is seated on a low stool, and with the other comb held in his right-hand he combs the wool upon the first, by introducing the points of the teeth of one comb into the wool contained in the other, and drawing them through it; this is repeated for 14 or 15 strokes, until the fibres of the wool are separated, disentangled, and laid parallel. In combing, he directs

rects the combs sometimes with the teeth of one parallel to the teeth of the other, and sometimes with the teeth of the two combs at right angles, or in a cross direction; but in all cases he must take care to begin gradually, by introducing the points of the teeth, first into the extremity of the wool which is contained in the teeth of the comb, and then penetrating deeper into the wool at every succeeding stroke, till at last he works the combs as near as he possibly can without actually bringing their teeth in contact: without this precaution, he could not draw the comb through the wool without breaking the fibres, and tearing the wool out of the teeth of the comb; but if he proceeds cautiously, the wool will be disentangled, separated, and straightened.

During the working, he frequently changes the combs, so as to work the wool upon both combs; but as the wool will gradually accumulate upon that comb which is most worked, he manages them so that at the end of about 35 or 40 strokes nearly all the wool will be gathered upon one of the combs, and will hang from its teeth in a fair lock of straight and regular wool. This comb he puts to heat for a moment, then fixes it to the post, and proceeds to draw off the wool from the comb in a sliver. To do this, he takes hold of the wool which projects from the teeth with the fingers and thumbs of both hands, and draws it away from the teeth of the comb in a direction perpendicular to their length, without sliding it off their points: as the wool comes away, he takes fresh hold, always seizing the wool at a given distance from the teeth. A portion of the wool which consists of short fibres will not come off, because it does not reach to the place where the comb grasps the wool; it therefore remains in the teeth of the comb, and is drawn off afterwards. This short wool, which is called noil, is unfit for worsted spinning; it is composed in part of the short fibres which are naturally intermixed in the long ones, and also of the fragments of long fibres which are broken in the process of combing. The quantity of the noil depends upon the kind of wool, and also on the care with which the comb has conducted his process; but it will seldom exceed $\frac{1}{4}$ th or $\frac{1}{5}$ th of the quantity of the raw wool by weight.

The wool which is drawn off from the comb forms a continued sliver or band, the fibres of which are straight and parallel, but not sufficiently so for spinning; it is therefore combed over again, and frequently it is repeated a third time. The first combing is called hacking, and the slivers produced by it are extended five together upon a table; then holding them down with one hand, they are broken again into handfuls by drawing them with the other. These are combed again in the manner before described, but the heat given to the combs is much less. The ultimate sliver, which is drawn off from the comb the last time, should be very even, and composed of long and parallel fibres. On examining it against the light, every part should appear equally dense, without any entanglements of the fibres, for on these particulars the perfection of the spinning will in a great measure depend.

The combed wool produced from sixteen pounds of wool usually weighs eleven or eleven and a half pounds, for about two pounds are lost in washing, and the rest in noil and waste in the combing. When the combing is finished, the slivers are formed into six parcels, each containing ten or eleven slivers, which are rolled up together into a ball, and ticketed with their weight and quality, the wool-comber's mark, and wool-stapler's mark. In this state, combed wool is called tops or Jersey, and is sold to the spinners in the country, and in cottages, who spin it into worsted-thread by the simple hand spinning-wheel; but the manufacturers who spin by machinery have wool-combers

at their mills, and they usually employ combing-machines in addition.

Combing-Machines.—The first combing-machine was invented by the Rev. Edmund Cartwright. His first two patents were in 1790, and he had another in 1792; but the machine was not rendered perfect, or brought into extensive use, till a later period: and in 1802 he obtained an act of parliament to renew or extend the term of his patent. The specification which he enrolled in consequence contains drawings and descriptions of machines nearly of the same kind as those which are now in use at many of the great worsted-mills, and which we shall describe. Mr. Cartwright proposed to form the raw wool into continued slivers, by joining the pieces of wool together, and slightly twisting them, and in this state they could be presented to the combing-machine; but as this plan was not found to succeed, it was found necessary to comb the wool first by hand, in order to reduce it to slivers. This is still the common practice, and takes away great part of the advantage of the machine; but we have seen a preparing-machine for this purpose, which operated very well upon the raw wool. The inventor's name we have not learned; but the rudiments of it are to be found in Mr. Cartwright's specification of 1790.

Preparing-Machine.—The raw wool is spread upon a horizontal feeding-cloth, which is extended over two rollers, and circulates upon them: by its motion, the wool is carried forwards, and presented to a pair of fluted rollers, which draw it in. This feeding-cloth is situated at the top of the machine, at the height of about five feet from the floor, so as to allow room for the rest of the machinery beneath it. A principal part of the machinery is carried by a horizontal wheel of five feet diameter, which is mounted upon a vertical axis, and is turned rapidly round by the mill. This wheel carries four porcupines, which are small cylindrical rollers, armed with spikes or teeth rather hooked. The rollers are situated horizontally in the plane of the wheel, with their length nearly in the direction of radius. They are about seven inches in diameter, and fourteen inches long, and are fixed upon horizontal spindles, which proceed from the circumference of the great wheel nearly to its centre, one extremity of each spindle being sustained by the rim of the wheel, and the other in a support fixed to the perpendicular axis. The porcupines are fixed on the ends of the spindles, near the circumference of the wheel, and on the opposite end of each spindle is a small cog-wheel, to work in a worm or endless screw, which is fixed concentric with the axis, being cut on the outside of a hollow tube, through which the vertical axis passes.

By this means, the four porcupines which the wheel contains have a two-fold motion, *viz.* they are all carried round in a circle by the motion of the wheel, and at the same time each one has a slow rotative motion on its own axis, in consequence of the cog-wheels, which work in the threads of the fixed worm.

The feeding-cloth is so situated, that the four porcupines in the great wheel will pass in succession exactly beneath the fluted rollers, which take the wool from the feeding-cloth, and the teeth of the four porcupines being sharp-pointed and rather bent forwards at the points, they penetrate and catch the wool as it comes through these fluted rollers, and hangs down from them. A portion of wool is thus carried away by each porcupine every time it passes beneath the fluted rollers; but by the slow revolving motion of the porcupines on their own axes, each one presents a different row of teeth every time, and thus by degrees they become clothed with the wool which they take up.

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This wool they deliver to a larger porcupine, which is placed beneath the revolving-wheel, or on the opposite side to the feeding-cloth. This porcupine is a cylinder nineteen inches diameter, and fourteen inches long: its axis is placed horizontally, and directed nearly to the centre of the vertical axis; so that the small porcupines will be parallel to the large one when they pass over it. The great porcupine is furnished with rows of teeth exactly similar to those of the small ones, which teeth are not very numerous, but large and sharp-pointed, and rather hooked, with the points forwards. When the small porcupines pass over the large one, there is so little clear space between their teeth, that the wool which is contained in the teeth of the small ones will be taken off by the large one, and remain in its teeth. The reason of this is, that the teeth of the large porcupine present themselves to the teeth of the small ones with the points forwards, and the small porcupines at the same time move with the points of their teeth backwards. It was before stated, that the porcupines move with the points forwards when they take the wool from the feeding-rollers, but this wool is applied on the upper side of the porcupines, and the great porcupine is at the lower side; hence the direction of the teeth is reverse in the two cases, and occasions the wool to be given to the great porcupine, a small quantity at a time, from each of the small porcupines, as they pass over it. The great porcupine being turned slowly round upon its axis clothes itself with the wool in a continued fleece, and this is drawn off from its teeth by a pair of fluted rollers, between which it passes in a continued sliver or band; this band is also conducted through a short tube, which revolves round its axis, and rolls up the sliver, to make it adhere better together in a round and compact form.

The action of this machine is not to comb the wool, but to divide the mass of raw wool, which is spread on the feeding-cloth, into a great number of small and equal portions by the successive strokes of the small porcupines; these portions are again mixed together in one film of wool upon the great porcupine, from which the wool is drawn off in a continued sliver, and as much twist is given to it as is requisite to make the sliver sufficiently compact to submit it to the combing-machine.

Cartwright's Combing-Machine, or Combing-Table; called also amongst the workmen *Big Ben*.—In *Plate II. fig. 1. Worsted Spinning*, is a horizontal plan of the machine, which exhibits nearly all its parts; we have also given a perspective view in *fig. 2.* of the operative parts, as they would appear if detached from the framing which sustains them. *AA* is a circular ring of wood, which is fixed down on the framing; *BB* is a similar ring, which is fitted into the fixed ring, with liberty to turn round within it. The interior of this ring is furnished with a row of comb-teeth, with the points directed to the centre, and there are two other rows of shorter teeth beneath, so as to make three circular rows of teeth. This forms a large circular comb, called the combing-table, about five feet diameter; it is moved slowly round in the direction of the arrow by means of a pinion, which works into a ring of cogs, fixed in segments within side of the circular comb beneath the row of teeth, as is shewn in the section, *fig. 3.*

The wool is filled upon the teeth of the circular comb by means of two machines *F* and *G*, called crank-lashers. These supply the wool by lashing or throwing the lock of wool upon the teeth of the comb, and then drawing up the wool from the comb, with a motion very similar to that of the hand of the workman in filling the combs, as we have before described. The crank-lashers repeat their strokes with great rapidity; but as the comb-table is kept in con-

tinual motion, the wool which is lashed upon the teeth by the first crank-lasher *F* is carried away, and in its course comes beneath the other crank-lasher *G*, by which more wool is filled upon the teeth, and they receive the intended portion. This wool, by the rotation of the comb-table, is then carried beneath a small comb *K*, which works by a crank movement, but with its teeth always horizontal; they penetrate through the wool, and then rise up so as to comb it. After this operation, the wool is taken off from the teeth of the comb-table between a double pair of fluted rollers *N*, situated immediately over the comb-teeth; these draw off the combed wool in a continued sliver, which is conducted through another pair of plain rollers *R*, and falls into a tin can placed there to receive it.

This machine was not found capable of combing the raw wool, chiefly because the comb-teeth are not heated, and also because the actions of lashing on the wool, and afterwards combing it, begin to act upon wool, at first with their full force, and break the fibres if they are entangled together; hence it is found best to comb the wool by hand once over, or for fine goods twice. The wool is thus formed into slivers, which are joined together, by laying them on a table, with the ends lapped over each other; and rolling them together, they will join into one long sliver. Three of these slivers are put into tin cans *ii*, which are placed upon a circular table *I*, and carried upwards to the crank-lasher *F* or *G*, which are both of similar construction. The table *I* is mounted on an axis, so as to be capable of turning slowly round horizontally, in order to twist the three slivers together into one; but in the machines which we have seen in use, this movement is commonly neglected, for if the slivers are prepared by hand-combing, as we have before described, they will hang together without twisting.

The slivers, which are carried up from the cans to the crank-lasher (see *fig. 3.*), first pass over a roller at *e*; the axle of this roller is also the fixed centre of motion of a trough *H*, which forms one part of the crank-lasher. The sliver of wool is conducted along the trough *H*, and then turns over a second roller at *f*; the centre-pin of this roller is the joint, which unites the end of the trough *H* with a moveable frame *dd*, which has a tube *g* fixed in front for the sliver of wool to pass through. A little below the middle of this frame *dd* are holes through its sides, to receive the pin of a crank *bb*, of which the central axis is supported in bearings secured to the frame of the machine, and it is turned round by the power of the mill. By means of a pair of bevelled wheels *D* and *E*, *fig. 1.* the cranks of the two crank-lashers are connected together, and have a common motion, but in a direction at right angles to each other. At the lower end of each of the moving frames *dd*, a pair of fluted rollers *i* are fixed, which draw the sliver between them. The rollers are put in motion by means of a cog-wheel *k*, fixed on the extremity of the axis of the lower roller; this is turned by a small pinion, fixed at the end of an axis, which passes through the frame *dd*, and which at the opposite end has a wheel *h*, that receives motion from a pinion fixed fast to the pin of the crank. The upper of the two fluted rollers is pressed down against the lower one by springs, which bear on its pivots with sufficient force to hold the wool firmly between them, and draw the sliver forwards when they turn round.

The motions of the crank-lasher are not easy to be understood from a verbal description. It must be recollected, that the upper end of the frame *dd* which carries the rollers, being jointed to the end of the trough *H*, it must always move in the arch of a circle, as shewn by the dotted lines, *fig. 3*; the centre of this arch is *e*: also that the middle part of the frame *d*, where the crank-pin passes through it,

it, must describe a circle when the crank revolves: in consequence, the rollers *i*, which are at the lower end of the frame, will move in a curve, as shewn by the dotted lines. It is an oval or distorted ellipsis, with the longest diameter horizontal.

At the same time the fluted rollers circulate in this orbit, they are in continual motion on their own axis, by the communication of wheel-work before described, and they draw the sliver of wool down the tube *g*; the end of the sliver, which projects from below the rollers, hangs down from them in a lock, and by the motion of the crank-lasher this is thrown against the points of the teeth in the comb-table. At the period when the wool is thus thrown on the teeth, the rollers are moving nearly in an horizontal direction, so as to draw the wool in the direction of the length of the teeth, and they penetrate the wool; but as the rollers proceed in their elliptic orbit, they begin to rise and draw the wool upwards away from the teeth in an inclined direction, as is evident by tracing the dotted course marked out for the rollers. By thus drawing up the wool between the teeth, a portion of the wool will be left in them; the rollers then rise up rapidly in their oval course, and the wool is raised quite above the teeth; the rollers then move forwards to make another stroke, and during such advance, the rollers, being in continual motion, draw forwards the sliver of wool, and the end hangs down ready to be lashed on the teeth of the comb next time.

The motions of the small comb *K* must be next described. The whole machine receives its motion by means of a wheel or pulley *c*, *fig. 1*, upon the axis of the crank for the lasher *G*; *D* and *E* are the bevelled wheels by which the other crank is turned; at the extreme end of the axis *C* is a pinion, which turns a bevelled wheel *L*, and on the axis of this is a wheel turning two others *M M* of equal size; on the extremities of the axes of the wheels *M M* are two cranks *ll* of equal radii, which are both jointed to an iron bar *mm*, and both turning round together in the same direction, they cause the bar to move in a direction parallel to itself, and every part of the bar describes a circle equal to the radius of the cranks. The small comb *K* is fixed to this bar, and partakes of its motion, whereby the points of its teeth are carried horizontally into the wool contained in the teeth of the great comb, then rise upwards and draw through the fibres, in order to comb them.

In order to remove the little comb when it becomes filled with wool, it is attached to the bar *m* by means of a comb-holder or socket *L*, which has a groove at each end to receive the little comb, and it can be mounted or withdrawn at pleasure. This socket *L* is moveable upon a horizontal pin fixed at the end of the bar *m*, so that it can be turned with either end upwards; and as the little comb can be fixed at either end of the socket, a spare comb is placed in the upper groove of the socket, whilst the lower groove holds the comb which is in use; but when this becomes filled with wool, which it has gathered from the comb-table, the socket *L* is inverted by turning it half round upon its centre-pin, and by this means the fresh comb is brought down into use, and the other can be taken away to clear off the wool from it. There is a small bolt fixed to the pin on which the socket *L* turns, which can be shot into a notch when the socket is in a perpendicular position, and will then hold the socket fast from turning, and keep the comb in a proper position for its work. In this way, the little comb can be taken away and replaced by a fresh one as often as is necessary, without stopping the machine, for the small comb does not move very quick. The same boy who attends to change the combs, when necessary,

also sets up the wool in the great comb-teeth with a small scraper, so that the small comb will penetrate through it with more certainty and effect. The plane of the rows of teeth in the small comb is not horizontal, or parallel to the teeth of the combing-table, but inclined thereto, so that those teeth of the small comb which first come into action upon the wool do not penetrate deeply into it; but as the comb-table turns round, the wool advances beneath the small comb, and is operated upon those teeth which go deeper, and the last teeth of the comb go as deep as they can, not to touch the teeth of the comb-table.

The wool is now combed, and only remains to be drawn off in a continued sliver; this is done by the drawing-off rollers *N*, which are fluted iron rollers, placed horizontally over the comb-teeth, and nearly in the direction of a radius of the comb-table: they are supported in an iron frame, and are turned round by a pair of bevelled wheels from a vertical axis *P*. This axis extends the whole height of the machine, and is put in motion by means of a pair of bevelled wheels, and an oblique axis *Q*, which is turned by a bevelled wheel and pinion on the extreme end of the axis of the first crank-lasher.

The great comb receives its motion from the perpendicular axis *P*, which turns a large wheel *T* by a pinion on the lower end of it: on the upper end of the axis of this wheel is the pinion which works in the ring of teeth within side of the comb-table: in this way, a very slow motion is given to the comb-table. There are two pair of drawing-off rollers *N*, situated close together, and parallel to each other; the first pair are put in motion as we have described, and the back pair are turned by means of equal cog-wheels, so that they move with the same velocity.

The wool upon the comb-table is gathered in the hand, to form a sliver, and the end is introduced between the rollers, which continually draw off the wool as the comb-table turns round. After passing through both pairs of rollers, the sliver is conducted through a forked iron, then through a round wooden tube, and is at last delivered by two plain wooden rollers *R* into a tin can placed beneath to receive it. These rollers are also turned by bevelled wheels on the perpendicular axis *P*. The drawing-off rollers only take away the long wool, the fibres of which are long enough to reach to the rollers. The two rollers composing the front pair of drawing-off rollers are not placed immediately over each other, but the upper roller overhangs the lower one, so that the plane in which the axes of the upper and lower rollers are both situated is inclined at about an angle of 45 degrees to the plane of the comb-table: by this means, the wool is drawn off from the comb, at an angle of 45 degrees, to pass between the rollers.

The noils, *i. e.* the short wool and broken fibres, which will not reach the drawing-off rollers, remain in the teeth of the comb-table, and also as much of the long wool as is on the lower side of the comb, and these are called backings: both are taken off by a boy, who is seated for that purpose within the circle of the comb-table; he first draws off the backings from beneath the comb, and then, with one hand above the teeth, and the other below, he draws off the noils.

These two sorts of wool are handed to a boy on the outside of the machine, who puts them into separate boxes. The backings are filled on the small combs before they are put into the machine, and become somewhat combed by the action of the small comb: when the small combs are removed from the machine, the wool upon them is further combed by hand, and then drawn off from them in a continued sliver, by means of an additional piece of machinery, which is at the side of the machine.

WORSTED MANUFACTURE.

This combing-machine is found to break the fibre of the wool, and it increases the quantity of noil very much, unless the wool is previously combed once or twice by hand; and as it then becomes only a substitute for the second or third combing, it saves little or no expence. The advantage of the machine is found, in the great regularity and equality of the sliver which is produced by it, a circumstance of particular importance for fine spinning. In combing by hand when the sliver is drawn off, those fibres which the comb first takes hold of are longer than the others; then as the sliver continues to be drawn, shorter fibres are found in it, and the shortest are last of all. These are called the long and short ends of the sliver; the short end is always marked by twisting or rolling it up, in order that when the slivers are joined together into one for spinning, the long and short ends may be equally intermixed and dispersed throughout the whole length. In drawing off the wool from the combing-machine, the long and short fibres are intermixed and taken up together, so that the sliver is of very equal texture.

There have been several other attempts to make combing-machines which deserve notice, though they have not come into use.

Messrs. Wright and Hawksley had a patent in 1793 for a combing-machine; and Mr. Toplis of Cuckney had also a patent of the same date, which contains some good ideas. Mr. Hawksley, in 1797, had a patent for improvements on Cartwright's: the principal one was, to make the combing-table by the combination of a number of small combs, which could readily be applied to the table, or detached at pleasure. If this would allow the combs to be heated, as the inventor proposed, they would work much better.

Mr. Amatt had a patent in 1795, and Mr. Pearce in 1798: after this time, Mr. Cartwright's machines had received some improvements from Mr. Hawksley, and came into use; and we find less speculation on the subject.

Gilpin's Combing-Machine.—In 1811, Mr. George Gilpin of Sheffield perfected a very ingenious machine, which combed the raw wool in a most complete manner. We do not hear that this machine is yet come into use, although we have no doubt of its answering the purpose, having frequently examined it while at work: its only fault was a complication of parts, which might be easily removed.

The outline of this machine is taken from that of Mr. Coplis in 1793, but is very much improved and perfected. *Fig. 4. of Plate I. Worsted,* is a sketch of the principal parts. The machine works with eight combs at once, which are of rather larger size than the ordinary hand-combs, the rows of teeth being twenty inches long. These combs are fixed upon two reels or frames A, B, which revolve upon their axes by the power of the mill; our combs, D and E, are fixed upon each reel, and in such position that both ends of the comb-teeth, *viz.* the points and roots, are equally distant from the centre of the reel to which they are fixed; and the reels, with the combs fixed upon them, form two revolving wheels or frames. The combs D and E are so made, that they can be detached from the reels, or replaced and fixed fast in a moment, by the attendants; and they can, therefore, be heated in a stove, in the same manner as the hand-combs. The wool is also filled upon the combs by hand, and the combs and wool are heated in the usual manner before they are put into the machine, in order to comb the wool.

One of these reels A is simply turned upon its axis, but the other reel B has a curious compound motion given to it by the machinery: thus it revolves on its own axis; but the axis also advances to, and recedes from, the other reel with

a motion parallel to itself, which is repeated four times in every revolution. Whilst B advances towards A, it moves with only one-third of the velocity with which it returns from A. The advancing movement is of a limited and constant extent; but at the same time, there is a third movement which regulates this extent, so that at every succeeding stroke which the machine makes, the two reels will approach nearer together.

Suppose all the combs filled with wool, and mounted in their places upon the reels, the machine is then put in motion, and the two reels A and B turning round in opposite directions, their combs D and E meet each other; and by the compound movement of B, (*viz.* advancing slowly towards A, and turning round at the same time,) the combs D and E approach in such a manner, that the points of each comb penetrate the wool which is in the other comb, and this is reciprocal of both combs. When the teeth are thus entered into the wool, the moveable reel B retreats quickly from the other, and the teeth, by drawing through the wool, comb and separate its fibres.

The circular motion of both reels is not regular and equable, but is communicated by means of elliptical cog-wheels, which occasion the reels to move round very slowly, at the moment when the comb of the reel B is drawing out or combing the wool; but this motion being finished, the reels begin to turn round more rapidly, and at the same time the reel B approaches towards A with a slow movement, in order to present another pair of combs to each other, which meet; and each one penetrates the wool which is upon the other, and then the reel B draws out to comb it, in the manner before described.

In this way they continue to make successive strokes, until the wool is sufficiently combed: the machine is then stopped, and the combs taken off one by one, to be replaced by others, which are filled with fresh wool, and properly heated.

There is likewise another movement of the reel A, which we have not yet mentioned: the axis of that reel has a slow motion backwards and forwards, endways in the direction of its length, for a short distance. The intention of this is, that the same parts of the combs shall never come opposite to each other at two successive strokes.

It should be observed, that when the machine is first set to work, the combs at their point of meeting do not come within three or four inches of each other, and the points only penetrate amongst the longest fibres of the wool upon the combs; but at every stroke which is made, the combs advance nearer together, and take deeper into the wool, until, after a certain number of strokes are made, the combs approach as near as they can without touching. They continue to work in this manner for some time, and when the intended number of strokes is made, a bell rings as an indication that the machine should be stopped. This is done by drawing a lever, and in consequence the machine will stop itself in the exact position for changing one of the combs on each reel. These are removed, and others ready filled with wool and heated are put on in their places, which being done on both reels at the same time by two persons, is only the work of a moment. The machine is then put in motion again, but by the machinery it will stop itself again at the required position for changing the next pair of combs; it is then put forwards, and so on, until all the eight combs are changed.

The combs which are removed from the machine are put into the stove to heat for a few moments, and then the wool is drawn off from them by a separate machine. The head of the comb is here placed in a perpendicular groove, so that its teeth stand horizontal; and a piece

of metal, which is fixed to the head of the comb, and projects therefrom like a tooth, enters into the spiral groove of a screw, which stands in a perpendicular position, and is continually turned round by the machinery. By this means, the comb is regularly and slowly let down in the groove, from top to bottom. A pair of fluted rollers is placed horizontally, and parallel to the teeth of the comb, in such a position that the comb, in descending, will pass with its teeth at a proper distance from them, to draw off the wool in a sliver. After passing through these fluted rollers, the sliver is conducted through a perpendicular revolving tube, which gives a roundness to it, the same as it would acquire by being rolled between the hands, and then it is conducted between a pair of plain rollers, which deliver it into a tin can placed before the machine.

A wooden roller is placed above the fluted rollers, with eight pieces of board projecting from it in the direction of radii. When the roller turns round, these boards act to stroke the wool upon the comb, and raise it into a proper situation to be drawn off by the fluted rollers.

The combs are prepared for drawing off the wool, by heating them as before mentioned, and by sliding the wool from the roots of the teeth half way towards their points. In this state, the combs are carried one by one to the drawing-off machine, and the head of one comb is put into the top of the perpendicular groove: it will be prevented from falling down in the groove by the projecting tooth, which enters the spiral groove of the perpendicular screw. The wool is gathered up and introduced between the fluted rollers; the machine is then put in motion, and by means of the screw the comb is gradually lowered down, and the wool is drawn off from it in a sliver, which is rolled up into a compact form by the revolving tube, through which it passes, and is delivered into the can by the plain rollers.

The attendant holds another comb ready to follow the first, and when the first has descended to a certain point, he slips the next comb into the perpendicular groove, so that it rests upon the former, and the wool upon the two combs joins as it were in one. The stroker, when they pass before it, lays the fibres all one way, and the wool is drawn off by the rollers in a continued sliver, which does not present the slightest appearance of joinings. Another comb is then put in, and the wool joins to the former, and so on. The backings, or wool at the back of the comb, are drawn off by the boy stationed behind the machine; and the combs, as they come through below, are received by boys, who afterwards take away the noil or short wool which remains in the teeth, and then put the combs back into the stove to heat them, ready to be filled again, in order to proceed with another combing. When the wool of all the eight combs is drawn off, the motion of the drawing-off machine is stopped at the moment when the eighth or last comb has descended half way through its course. In this state, the machine waits till another combing is finished, and then the succeeding comb being placed on the top of that one which continues in the machine, the continuity of the sliver will be preserved.

The inventor of this machine states in his specification, that for common work the wool only requires to be operated upon once by the combing-machine; and in that case, the machine must be adapted to make twenty-four strokes of each pair of combs before the bell rings. For medium work, such as would require to be combed twice over, in the usual manner of hand-combing, it must be combed twice over by the machine: thus, after having been combed once in the manner before described, the sliver of wool is broken up into handfuls, and filled on the combs again by hand as

before, and combed over again in a similar manner; but the combs are less heated for the second time of combing. By changing a wheel, the machine should be adapted to make only fourteen or sixteen strokes before it stops, when it is intended to comb twice over. The wool intended for the finest spinning should be combed three times over, and the machine should be set to make fourteen or sixteen strokes of each pair of combs.

The machine has also two different movements for the drawing out of the moveable comb-reel: in one, the motion is over a space of ten inches, and is adapted to comb such wool as is six or eight inches length of staple, and is called wether wool; but by a slight alteration, the excursion of the moveable reel can be increased to thirteen inches, and is then adapted to comb hey wool, or wool which is from eight to eleven inches length of staple.

Mr. Gilpin's machine has the advantages of heating the combs and of filling them by hand, both of which are essential to any machine which is proposed to comb the raw wool. The filling is an operation which requires discretion, if it is expected that the long fibres shall be preserved without breaking. The person who fills the wool on the teeth takes a greater or less lock of wool in his hand, according to the condition of it, and the degree of entanglement: also in drawing it between the comb-teeth, the force is proportioned to what the wool will bear. Mr. Gilpin's specification states, that under certain circumstances, when the wool will not wash well, but remains taggy, it is advisable to fill it upon the combs, and slip it off; then fill it again, preparatory for the machine. As the object of this first filling is chiefly to warm the wool, the end may be in part attained by laying the wool upon the top of the stove for a few minutes before it is filled.

Planking.—Let us suppose that the wool is combed either by the hand, or by the machine, and we will proceed to explain the means of preparing it into a thread. The combing-machines reduce the wool into a continued sliver, which is ready for the drawing-frame; but the short slivers produced by the hand-combing must be first joined together by what is called planking. These slivers are rolled up by the combers, ten or twelve together, in balls called tops, each of which weighs half a pound: at the spinning-mill these are unrolled, and the slivers are laid on a long plank or trough, with the ends lapping over, in order to splice the long end of one sliver into the short end of another. The distinction of the two ends of the sliver has been before explained; the long end being that which was first drawn off from the comb, and contains the longest fibres of the wool; the short end is that which came last from the comb, and contains the short fibres. The wool-comber lays all the slivers of each ball the same way, and marks the long end of each by twitting up the end of the sliver. It is a curious circumstance, that when a top or ball of slivers is unrolled and stretched out straight, they will not separate from each other without tearing and breaking, if the separation is begun at the short ends, but if they are first parted at the long ends they will readily separate.

Breaking-Frame.—Here the slivers are planked or spliced together, the long end of one to the short end of another; they are immediately drawn out and extended by the rollers of the breaking-frame. A sketch of this machine is given in *Plate II. fig. 5*; it consists of four pairs of rollers, A, B, C, D. The first pair A receives the wool from the inclined trough E, which is the planking-table. The slivers are unrolled, parted, and hung loosely over a pin, in reach of the attendant, who takes a sliver and lays it flat in the trough, and the end is presented to the rollers A, which being in motion

WORSTED MANUFACTURE.

motion will draw the wool in; the sliver is then conducted through the other rollers, as shewn in the figure: when the sliver has passed half through, the end of another sliver is placed upon the middle of the first, and they pass through together; when this second is passed half through, the end of a third is applied upon the middle of it, and in this way the short slivers produced by the combing are joined into one regular and even sliver.

The lower roller C receives its motion from the mill, by means of a pulley upon the end of its axis, and an endless strap. The roller which is immediately over it is borne down by a heavy weight *e*, suspended from hooks, which pass over the pivots of the upper roller. The fourth pair of rollers D moves with the same velocity as C, being turned by means of a small wheel upon the end of the axis of the roller C, which turns a wheel of the same size upon the axis of the roller D, by means of an intermediate wheel *d*, which makes both rollers turn the same way round. The first and second pairs of rollers, A and B, move only one-third as quick as C and D, in order to draw out the sliver between B and C to three times the length it was when put on the planking-table. The slow motion of the rollers A is given by a large wheel *a*, fixed upon the axis of the roller A, and turned by the intermediate cog-wheels *b*, *c*, and *d*; the latter communicates between the rollers C and D. The pinions on the rollers C and D being only one-third the size of the wheel *a*, C and D turn three times as fast as A, for *b*, *c*, and *d*, are only intermediate wheels. The rollers B turn at the same rate as A. The upper roller *c* is loaded with a heavy weight, similar to the rollers A; but the other rollers, B and D, are no farther loaded than the weight of the rollers.

The two pairs of rollers A B and C D are mounted in separate frames, and that frame which contains the third and fourth pairs, C D, slides upon the cast-iron frame F, which supports the machine, in order to increase or diminish the distance between the rollers B and C. There is a screw *f*, by which the frame of the rollers is moved, so as to adjust the machine according to the length of the fibre of the wool. The space between B and C should be rather more than the length of the fibres of the wool. The intermediate wheels *b* and *c* are supported upon pieces of iron, which are moveable on centres: the centre for the piece which supports the wheel *b* is concentric with the axis of the roller A; and the supporting piece for the wheel *c* is fitted on the centre of the wheel *d*. By moving these pieces, the intermediate wheels *b* and *c* can be always kept in contact, although the distance between the rollers is varied at times. By means of this breaking-frame, the perpetual sliver which is made up by planking the slivers together is equalized, and drawn out three times in length, and delivered into the can G.

Drawing-Frame.—Three of these cans are removed to the drawing-frame, which is similar to the breaking-frame, except that there is no planking-table E. There are five sets of rollers, all fixed upon one common frame F, the breaking-frame which we have described being the first. As fast as the sliver comes through one set of rollers, it is received into a can, and then three of these cans are put together, and passed again through another set of rollers. In the whole, the wool must pass through the breaker and four drawing-frames before the roving is begun. The draught being usually four times at each operation of drawing, and three times in the breaking, the whole will be $3 \times 4 \times 4 \times 4 \times 4 = 768$; but to suit different sorts of wool, the three last drawing-frames are capable of making a greater draught, even to five times, by changing

the pinions; accordingly the draught will be $3 \times 4 \times 5 \times 5 \times 5 = 1500$ times.

The size of the sliver is diminished by these repeated drawings, because only three slivers are put together, and they are drawn out four times; so that in the whole, the sliver is reduced to a fourth or a ninth of its original bulk.

The breaking-frame and drawing-frame, which are used when the slivers are prepared by the combing-machines, are differently constructed; they have no planking-table, but receive three of the perpetual slivers of the combing-machine from as many tin cans, and draws them out from ten to twelve times. In this case, all the four rollers contribute to the operation of drawing: thus the second rollers B move $2\frac{2}{3}$ times as fast as the rollers A; the third rollers C move 8 times as fast as A; and the fourth rollers E move $10\frac{1}{3}$ times as fast as A. In this case, the motion is given to the different rollers by means of bevelled wheels, and a horizontal axis, which extends across the ends of all the four rollers, to communicate motion from one pair of rollers to another.

There are three of these systems of rollers, which are all mounted on the same frame; and the first one, through which the wool passes, is called the breaking-frame, but it does not differ from the others, which are called drawing-frames. The slivers which have passed through one system of rollers are collected four or five together, and put through the drawing-rollers. In all, the slivers pass through three drawings, and the whole extension is seldom less than 1000 times, and for some kinds of wool much greater.

After the drawing of the slivers is finished, a pound weight is taken, and is measured by means of a cylinder, in order to ascertain if the drawing has been properly conducted; if the sliver does not prove of the length proposed, according to the size of worsted which is intended to be spun, the pinions of some of the drawing-frames are changed, to make the draught more or less, until it is found by experiment that one pound of the sliver measures the required length.

Roving-Frame.—This is provided with rollers the same as the drawing-frames: it takes in one or two slivers together, and draws them out four times. By this extension, the sliver becomes so small, that it would break with the slightest force, and it is therefore necessary to give some twist; this is done by a spindle and flyer. (See *fig. 6.*) A B are the two pairs of rollers, between which the sliver is passed; the first rollers A turn round slowly, but the others B revolve four times as quick, to draw the sliver to four times its original length; and as fast as it issues from the roller, it is twisted by the motion of the spindle C, and wound up upon the bobbin *a*. The spindle C is put in motion by a whip-cord band, which passes round the pulley *c*, and also round the wheel D. This wheel is fixed on a vertical axis *e*, which has a pinion on the upper end, to give motion to the lower roller B, by means of a bevelled wheel upon the end of its axis. The opposite end of the axis has also a bevelled pinion upon it, to give motion to a bevelled wheel fixed upon an horizontal axis, which carries another bevelled pinion, to give motion to a bevelled wheel fixed upon the end of the axis of the back rollers A. The sizes of these wheels and pinions are so proportioned, that the back rollers A turn only once to every four turns of the front rollers B, as before mentioned.

The back rollers are capable of being set at a greater or less distance from the front rollers, according to the length of the fibres of the wool, and in all cases the distance should be rather more than the length of the fibres, but not a great deal.

The spindle is supported on its point, and sustained by a collar at the middle of its length. Upon the top of the spindle, the flyer *e* is screwed; it has two branches, which turn downward, and one of them has an eye at the lower end, through which the roving is conducted, in order to lay it upon the bobbin *a*. This bobbin is fitted loosely upon the upper part of the spindle, and rests with its weight upon a piece of wood projecting from the bobbin-rail *f*. The rail is made to rise and fall continually with a slow motion, so as to present every part of the bobbin in succession to the eye of the flyer, and thereby wind the roving upon every part of the length of the bobbin. The bobbin is not fixed upon the spindle, but is fitted loosely thereupon; and by resting upon the piece of wood which is fixed to the bobbin-rail, there is so much friction and resistance to the motion of the bobbin, that it gathers up the roving by winding it round itself as fast as the rollers give it out. The twist given to the roving is just enough to make it hang together, and one turn in each inch is usually enough. Some roving-frames are made with four pairs of rollers, and draw ten or twelve times; and in this way, it is not necessary for the sliver to pass so frequently through the drawing-frame.

Spinning-Frame.—This is so much like the roving-frame, that a short description will be sufficient. The spindles are more delicate, and there are three pairs of rollers instead of two; the bobbins which are taken off from the spindles of the roving-frame, when they are quite full, are stuck upon wires at *L* (*fig. 7.*), and the roving which proceeds from them is conducted between the rollers. The back pair *A* turns round slowly; the middle pair turns about twice for once of the back rollers; and the front pair *B* makes from twelve to seventeen turns for one turn of the back rollers *B*, according to the pinions which are employed, and these can be changed according to the degree of extension which is required.

The spindles must revolve very quickly in the spinning-frame, in order to give the requisite degree of twist to the worsted. The hardest twisted worsted is called tammy-warp, and when the size of this worsted is such as to be twenty or twenty-four hanks to the pound weight, the twist is about ten turns in each inch of length. The least twist is given to the worsted for fine hosiery, which is from eighteen to twenty-four hanks to the pound. The twist is from five to six turns *per* inch. The degree of twist is regulated by the size of the whirls or pulleys upon the spindle, and by the wheel-work, which communicates the motion to the front rollers from the band-wheel, which turns the spindles.

It is needless to enter more minutely into the description of the spinning machinery for worsted, because the construction is very similar to the water-frame for spinning cotton, invented by sir Richard Arkwright, and which is fully described in our article *Manufacture of COTTON*. The differences between the two are chiefly in the distance between the rollers, which in the worsted-frame is capable of being increased or diminished at pleasure, according to the length of the fibres of the wool, and the draught or extension of the roving is far greater than in the cotton.

Reeling.—The bobbins of the spinning-frame are placed in a row upon wires before a long horizontal reel, and the threads from 20 bobbins are wound off together. The reel is exactly a yard in circumference, and when it has wound off 80 turns, it rings a bell; the motion of the reel is then stopped, and a thread is passed round the 80 turns or folds which each thread has made: the reeling is then continued till another 80 yards is wound off, which is also separated by interweaving the same thread; each of these

separate parcels is called a ley, and when seven such leys are reeled, it is called a hank, which contains 560 yards. When this quantity is reeled off, the ends of the binding thread are tied together, to bind each hank fast, and one of the rails of the reel is struck to loosen the hanks, and they are drawn off at the end of the reel. These hanks are next hung upon a hook, and twisted up hard by a stick, then doubled, and the two parts twisted together, to make a firm bundle. In this state, the hanks are weighed by a small index-machine, which denotes what number of the hanks will weigh a pound, and they are sorted accordingly into different parcels. It is by this means that the number of the worsted is ascertained as the denomination for its fineness: thus No. 24. means that 24 hanks, each containing 560 yards, will weigh a pound, and so on.

This denomination is different from that used for cotton, because the hank of cotton contains 840 yards instead of 560; but in some places, the worsted hank is made of the same length as the cotton.

To pack up the worsted for market, the proper number of hanks are collected to make a pound, according to the number which has been ascertained; these are weighed as a proof of the correctness of the sorting, then tied up in bundles of one pound each, and four of these bundles are again tied together. Then 60 such bundles are packed up in a sheet, making a bale of 240 pounds, ready for market.

From this account of the processes of worsted spinning, it will be seen that they are very similar to those of cotton-spinning, after the first preparation of the wool by combing instead of carding.

Worsted-Cord, in *Sheep-Farming*, is a sort of cord which is sometimes used for tying round the necks of sheep affected with the scab, after it has been well smeared over with the common mercurial ointment of the shops, in order to cure them of that disease. See *SCAB*.

WORT, in the *Materia Medica*, is the sweet infusion of malt; first proposed by Dr. Macbride as a dietetic article to scorbutic persons, from an apprehension that it would ferment in their bowels, and give out its fixed air, by the antiseptic powers of which the strong tendency to putrefaction in this disease might be corrected. It was some time before a fair trial of this proposed remedy could be obtained, and different reports were made concerning it. In 1762, the lords of the admiralty gave orders to have the wort tried in the naval hospitals at Portsmouth and Plymouth; but the murmurs of the patients, on account of restrictions that were necessary for determining its efficacy, put a stop to the farther exhibition of it; and indeed Dr. Huxham, in 1764, informed the ingenious and benevolent proposer of this remedy, that it had been tried with very bad effects. But Dr. Macbride assures us, on the testimony of a gentleman who made use of the wort, that it may be taken for a length of time, to the quantity of a quart in the day, without producing any ill effect whatever; and he refers to Van Swieten's Commentary, vol. iv. p. 673. where we learn, that the baron's lady, when a nurse, used regularly to drink a pint of it every night going to bed, in order to increase her milk.

After the failure of success in the naval hospitals, orders were issued to have the wort administered on ship-board, where no temptations of fresh vegetables would offer to make the men uneasy. But a considerable time elapsed, before any reports were made either of its good or bad effects. Dr. Macbride, however, persisted in recommending

ing it, and lived to publish several cases, in a postscript to the second edition of his work, in 1767, from which it appears, that scorbutic complaints of the most dangerous kind have actually been cured at sea by the use of wort. Its general effects were, to keep the patients open, and to prove highly nutritious and strengthening; it sometimes purged too much; but this effect was easily obviated by the tinctura thebaica. Other unquestionable cases of its success in this disease are to be seen in the London Med. Obs. and Inq. vol. v. p. 61. See also SCURVY.

The use of wort has hence been adopted in other cases, where a strong putrid disposition in the fluids appeared to prevail, as in cancerous and phagædenic ulcers; and instances are published of its remarkable good effects in these cases. See London Med. Obs. and Inq. vol. iv. p. 367, &c. Priestley on Air, vol. 3. Appendix.

As the efficacy of the malt infusion depends upon its producing changes in the whole mass of fluids, it is obvious that it must be taken in large quantities for a considerable length of time, and rather as an article of diet than medicine. The quantity of one to four pints has generally been directed. See SCURVY.

WORT, *Improved Machine for stirring Malt in making of, in Rural Economy*, a contrivance for this purpose in brewing and distilling, suited to vats of this sort, which are employed in forming the wort or wash. There are many modes of stirring malt in the vats or tubs for mashing in, employed in different places and instances; but they are in most cases either expensive, or inadequate to the purposes as well as the powers which are made use of in the work. Among the former may be ranked the admirably well-contrived machine that is in use by Jellet and Co. at Dollhill, in Somersetshire, which is on a planetary system, and answers the intention very effectually; but its great cost renders it liable to objection in many cases. The well-known contrivance of a male screw standing upright in the centre of the vat, on which a bar works by means of a female screw operating on the male standard one, and thus causing the spikes with which the different wings of the bar are armed to stir the malt as the spiral motion proceeds, is certainly simple, neat, and cheap; but as it requires two men, one at each end, and makes but little change of locality among the malt-grain, much cannot be urged in favour of its efficiency for this use. The instrument known by the name of the hedge-hog, which is in use in some breweries, is a dreadful-looking machine, that would seem intended to divide some very tough or viscid substance rather than to stir malt in this intention. It consists of a roller about two feet in diameter, and six or seven in length, made of iron skeleton work; the longitudinal bars are bound with rings or hoops, furnished with spiky rims, to keep in due bounds a sort of chain-work, armed also with spikes, which chains revolve upon the rings as the frame rolls round, urged by the power of horses, and thus not only tears a passage through the contents of the mashing-vat, but keeps raking them up, carrying a considerable portion with the spiky chain quite over the wheel, and exposing the malt perpetually to the influence and action of the air; a practice invariably disapproved of by all good brewers. In this case, there are expence, labour, friction, &c. all crowded into one form, without any material advantage.

A plan has, however, been lately suggested for stirring malt while in the mashing-vat by a machine or contrivance wrought by the power of horses, or in other ways, which is nearly without friction, and divested of the intervention of any secondary action that may be troublesome or expensive. It is very simple; and one vat of this sort may be stirred

by a very trifling power; but as in large breweries and distilleries from malt a number of mashing-vats are mostly requisite, which generally require to be stirred in succession, an arrangement is given for facilitating and bringing the operations of five vats, one in the middle and four around it, into a narrow or small compass, and under the action of one power; which not only affords much convenience, but occasions the expence and the labour to be greatly lessened; consequently it may be useful in large as well as small establishments of this nature.

In this plan, the central circular vat for this purpose is raised sufficiently to admit the necessary gear and other matters for a horse-walk underneath it. The upright axle passes through the floor, and through the centre of the vat, proceeding up to a beam in which it moves in a metal bush, as it does also below, where it rests on a step. It does not, however, touch either the floor or the vat; but at the distance of a few inches it is surrounded by a cylinder, forming part of the vat, which prevents its contents from passing through the aperture in the floor. This cylinder corresponds in height with the exterior edge of the vat, and is firmly closed at the bottom, where, as well as at the outer part, it is rounded off, so as to be the more easily drained and cleaned.

As it is requisite at times to move the malt in the other vats, while the central one is at rest, there arises a necessity for constructing the wings of the stirring-frame in the latter in such a manner as may liberate them, leaving them inactive, while the axle proceeds in its ordinary revolutions.

The stirring-frame is made of iron; it has four wings standing at right angles, and they all join to an iron collar which surrounds the axle at some distance, that is, leaving about an inch intermediately all around. When the stirring-frame is to move with the axle, it is fastened to it by two iron pins, with long handles, so as to enable the workmen to affix them in their proper sockets, without going into the vat. These pins pass through the collar into the axle, thereby causing the stirring-frame to move round in the vat, as the axle is moved round by the horse, or other power.

As the stirring-frame in the centre vat cannot be connected all the way down its depth with the axle, on account of the cylinder, and as it would be liable to swag, if depending entirely on its junction with the collar, oblique stays are indispensable; they are carried out about two-thirds of the length of the frame, where they are rivetted: their upper ends are secured to another collar, surrounding the axle above.

Each wing of the frame consists of two iron bars, one at the top, and one at the bottom; between the bars are three fixed upright valves made of thin sheet-iron, and standing at angles of forty-five degrees; and they are fastened above and below into the horizontal iron bars, so as to be perfectly strong and steady in their positions. The valves do not, however, all stand the same way: the internal ones all point inwards, the outward ones all point outwards, and the middle ones alternately inwards and outwards.

Thus far wholly relates to the central vat, which may be surrounded by four others of less capacity, in which there will be found the differences noticed below: 1. That the bottoms not being perforated no cylinders are required. 2. That the axles for their respective frames rest on steps at their bottoms, in which iron gudgeons move in iron bushes. 3. That the frames all connect with the axles for the whole of their depth. And 4. That no stays or collars are wanted in them.

On the main axle are four drums of about one-fourth the diameter of the centre vat ; they are each about one foot in thickness, and deeply grooved all around, like the sheave of a pulley, for the purpose of receiving a band. An interval of about six inches is left between them, in the intention of receiving the band respectively, so that the corresponding drums on the axles in the other vats may be left at rest whenever those vats are not at work. Thus the four drums which are firmly fixed to the main axle, and revolve with it, turn the four drums fixed to the axles in the four vats respectively. But as the four drums on the main axle are all of different heights from the surface of the vat, the several drums on the axles in the other vats must be respectively of corresponding heights with those that act upon them on the main axle. An idea of the manner in which the bands extend to the four vats may be formed by observing that in order to produce greater constriction, and consequently greater power, they all form a figure of 8 in their progress ; thereby occasioning the four furrouring vats to be stirred by a counter motion : that is, the frames will revolve the opposite way to that in the central vat. The drum on each of the lesser vats should, however, be of the same size as that on the central axis from which it receives its motion, whereby the whole will move at the same rate, and the malt be equally stirred.

The intervals between the different vats will allow ample access to the works, and admit besides of standards, &c. for the support of the flooring above, there being no part of the machinery that in the least interferes with those spaces ; and the bands being completely out of the passage of all work, they can be easily shifted off and on to the central drum by means of a pole with an iron at its end, formed so as to embrace and direct them into the grooves.

On the whole it is supposed, that the plan here laid down may be safely asserted to be cheap, simple, and effectual ; and that it would not probably be easy to find any machinery for this use less complex, and in which the power is so immediately applicable to the object. For though it might be objectionable in work requiring perfect regularity, and an unvaried equable motion, without which the operations would be ill performed, and the machinery itself be liable to great injury, and to be perpetually out of order, yet in the business of merely stirring the malt in a mashing-vat in the making of wort or wash, inequality of motion can never produce any bad effect.

The driving power in these cases should move rather slowly, and when of the animal kind, it may be increased without the addition of more strength, merely by extending the length of the lever, and causing the animal by such means to describe a larger circle ; but which may not, however, be always convenient for want of perpendicular support for the flooring above. On most occasions, the mashing-vats in making wort or wash may, however, be computed not to exceed twelve feet in diameter, in which cases the horse-walks need not be more than twenty feet over, equal to about twenty yards in circumference ; and in this case, supposing the horse to move at the rate of two miles in the hour, he would go round eighty-eight times in the course of that time, and cause the malt to be stirred nearly three times in the space of every two minutes ; but if the lever were longer, the motion within the vats would be slower in proportion.

WORTH, in *Geography*, a town of Bavaria ; 12 miles E. of Ratisbon.—Also, a town of the principality of Hesse Darmstadt ; 20 miles E.S.E. of Darmstadt.

WORTH Barrow Bay, a bay of the English Channel, on

the fourth coast of the county of Dorset ; 11 miles E. of Weymouth.

WORTHIEST of Blood, in *Law*, an expression denoting the preference given in descents to sons before daughters.

WORTHING, in *Geography*, a fashionable and much-frequented watering-place in the parish of Broadwater, and county of Suffex, England, is situated on the sea-coast, 11 miles W. from Brightelmstone, $9\frac{1}{2}$ E.S.E. from Arundel, and 58 S. by W. from London. Formerly an obscure fishing-village, Worthing is much indebted for its present improvement to its situation on a very extensive stretch of fine level sandy beach, peculiarly convenient for bathing, and to the range of chalk-hills behind it called the South Downs, affording at once shelter to the town and sands, and space for exercise to the invalid. The town extends northward from the shore, but some new buildings are situated near the beach, and are adapted to the reception of families of the first rank. The Steyne, a range of handsome houses, and the parallel row called Warwick-buildings, form the E. and W. sides of a square, open to the sea on the S. and to the Downs on the N. A quarter of a mile from the beach is a neat chapel, erected by subscription in 1812. Worthing has a theatre, libraries, bathing-machines, and warm baths, and is thus amply provided for the use and amusement of visitors. Warwick-house is not only the most distinguished mansion in Worthing, but for its extent and appearance entitled to a high rank among the noble mansions of the kingdom. It was erected by the earl of Warwick, while proprietor of the manor of Broadwater ; but no longer belonging to that family, it is usually occupied by some persons of distinction in the bathing-season. Broadwater village is half a mile from Worthing ; it was the chief place of the barony of Camois, in the time of Edward I. The parish also comprehends Offington, the ancient but now much-altered seat of the lords de la Warr. The church of Broadwater is constructed on the cathedral plan, with a mixture of the circular and early-pointed styles of architecture. The population of Worthing fluctuates according to the season of the year ; but that of the whole parish of Broadwater, in 1811, was 2692 persons, and the houses were 629.—*Beauties of England and Wales, Suffex ;* By F. Shoberl, 8vo. London, 1813.

WORTHINGTON, a post-town of Massachusetts, in the county of Hampshire, containing 1391 inhabitants ; 19 miles N.W. of Northampton.

WORTLEY, a township in the parish of Tankersley, and county of York, England. According to the population report of 1811, it contained 173 houses, and 925 inhabitants, most of whom were employed in agriculture.

WORTON CREEK, a river of Maryland, which runs into the Chesapeake, N. lat. $39^{\circ} 20'$. W. long. $76^{\circ} 16'$.

WORTOWA, a town of Bohemia, in the circle of Chrudim ; 14 miles S. of Chrudim.

WORUMBANG, a town of Africa, in Mandingo. N. lat. $12^{\circ} 40'$. W. long. $6^{\circ} 55'$.

WOSCHNICK, or **WOZNICKI**, a town of Silesia, in the principality of Oppeln ; 14 miles N.N.E. of Beuthen.

WOSITZ, a town of Pomerelia ; 10 miles S.E. of Dantzic.

WOSSBERK. See **WEISENBERG**.

WOSTERZEDECK, a town of Bohemia, in the circle of Kaurzim ; 12 miles S.W. of Kaurzim.

WOSTOCK, a town of Brandenburg, in the Middle Mark ; 11 miles S.S.E. of Berlin.

WOSTROW, a town of Bohemia, in the circle of Czaflau ; 12 miles S.W. of Czaflau.

WOTCHAT,

WOTCHAT, in *Agriculture and Rural Economy*, a term provincially applied in some districts to an orchard.

WOTRALLY, in *Geography*, a town of Hindoostan, in Myfore; 8 miles N. of Allumbaddy.

WOTROW. See OSTRITZ.

WOTTON, Sir HENRY, in *Biography*, was born at Boughton-hall, in Kent, in 1568, and in 1584 entered of New college, Oxford, from which he removed to Queen's college. During his residence in the university, he applied with diligence to the study of logic and philosophy, of polite literature and civil law, and at this time composed a tragedy, which gained the applause of his fellow-collegians. Upon the death of his father in 1589, he availed himself of the small patrimony that was left to him in travelling through France, Italy, Germany, and the Low Countries, in order to improve his acquaintance with men and manners in these several countries. On his return in 1596, he was appointed secretary to the earl of Essex; and when this nobleman was apprehended on a charge of high treason, he consulted his own safety by quitting the kingdom. As he fixed his residence chiefly at Florence, he employed himself in composing a treatise, which was published after his death in 1657, under the title of "The State of Christendom; or, a most exact and curious Discovery of many secret Passages and hidden Mysteries of the Times." When a plot was detected by the grand-duke of Tuscany for taking away the life of James, king of Scotland, Wotton was engaged to communicate intelligence of it to the king. Having fulfilled this mission, he returned to Florence; and when James came to the crown, he recompensed his service by conferring upon him the honour of knighthood. In 1604 he was appointed ambassador in ordinary to Venice, where he acquired such reputation that several young gentlemen of rank attended him for improvement. In his way through Augsburg, he drew up the following humorous definition of an ambassador:—"Legatus est vir bonus peregre missus ad mentiendum reipublicæ causa;" *i. e.* an ambassador is a good man, sent abroad to lie for the service of his country. This sentence was afterwards alleged as a maxim avowed by the religion professed by the king of England; and it so far excited the displeasure of James, that Wotton, after his return, remained for five years unemployed. An apology, however, regained the royal favour, and he was sent on an embassy first to the United Provinces, and afterwards in 1615 to Venice. After three years' residence he returned with the hope of succeeding to the office of secretary Winwood, but he was otherwise employed in various foreign embassies, from the last of which to Venice he did not return till after the death of James, when he was appointed, as a recompence for his services, to the provostship of Eton college in 1624. Soon after his settlement in this situation, he published his "Elements of Architecture." But as the statutes of the college required his assuming the clerical character, he took deacon's orders, without undertaking what he considered as too serious a charge, the cure of souls. In his domestic entertainments he maintained the reputation of hospitality, and in his connection with the seminary over which he presided, he was a liberal encourager of genius and application. For the amusement of advanced life he had contemplated a life of Luther, with the history of the Reformation; but Charles I. persuaded him to undertake a history of England, in which, however, he made little progress. Having large demands on government for money advanced in foreign services, his circumstances were embarrassed, and he frequently solicited his majesty to grant him new preferment. But death was the only termination

of his wants and wishes; and this happened in December 1639, in the 72d year of his age. His remains were interred in the chapel of Eton college, and the following epitaph was inscribed on the stone that covered them by his own order: "Hic jacet hujus sententiæ primus autor, *Disputandi Pruritus Ecclesiarum Scabies*. Nomen alias quære." His accomplishments and literary acquisitions were very distinguished; and they are hyperbolically stated in Cowley's elegy, when he speaks of him as one

"Who had so many languages in store,
That only fame shall speak of him in more."

Business occupied so much of his time, that he had little leisure for writing. After his death were published his "Reliquiæ Wottonianæ;" and they have often been reprinted. Of his poems, there is one entitled "A Hymn to my God in a Night of my late Sickness," which has been highly extolled. *Biog. Brit.*

WOTTON, WILLIAM, a learned clergyman, was born in 1666, and under the tuition of his father, who was also a clergyman, he became a perfect phenomenon as to the knowledge of languages; for at the age of five years he could read the Latin, Greek, and Hebrew languages almost as well as English. Accordingly he was entered of Catharine-hall, Cambridge, some months before he was ten years of age: at twelve years and five months he took the degree of B.A., some time before which he had been celebrated in a copy of verses by Dr. Dupont, not only for his acquaintance with the learned languages, including Arabic, Syriac, and Chaldee, but his knowledge of geography, logic, philosophy, mathematics, and chronology. He commenced B.D. in 1691, and being chaplain to the earl of Nottingham, this nobleman presented him in 1693 to the rectory of Middleton-Keynes, in Buckinghamshire. His first work appeared in 1694, and was entitled "Reflections upon Ancient and Modern Learning." A second edition was published in 1697, and to this was annexed Dr. Bentley's Dissertation upon Phalaris, which involved Wotton in controversy, and subjected him to the sarcasm of Swift's *Battle of Books*. Wotton defended his own book against the objections of Sir W. Temple and others, and some observations in the *Tale of a Tub*, in the third edition in 1705. In 1701 he published "The History of Rome, from the Death of Antoninus Pius to the Death of Severus Alexander," 8vo. undertaken at the request of bishop Burnet, for the use of his pupil the duke of Gloucester; and recommended by Leibnitz to George II. when electoral prince. In 1706 he attacked "Tindal's Rights of the Christian Church," and in 1707 archbishop Tenison conferred upon him the degree of D.D. Notwithstanding his talents and learning, his life was irregular, and of course his circumstances embarrassed, so that in 1714 he was obliged to retire into South Wales, where he employed himself in writing. He also acquired the Welsh language, and was able to preach in it. Dr. Wotton, says one of his biographers, was one of those scholars, whose early proficiency, being chiefly the result of an extraordinary memory, was not followed by mature products corresponding to the expectations they excited. He died at the age of 60, in the year 1726. *Nichols's Lit. Anecd. Gen. Biog.*

WOTTON-under-Edge, in *Geography*, a large and populous market-town in the upper division of the hundred of Berkeley, Gloucestershire, England, is situated at the base of a ridge of woody hills (whence its name is evidently derived), at the distance of 19 miles S.S.W. from Gloucester, and 108 miles W. by S. from London. It is a borough by prescription, though it sends no members to parliament. In the

the reign of king John it was nearly destroyed by fire, and a place called the Brands is supposed to mark its ancient site. The present town consists of several streets, and stands on nearly sixty acres of ground; the buildings in general are good, and some, belonging to families of property, are modern and elegant. The government of the town is vested in a mayor and twelve aldermen. In the year 1252, Maurice, lord Berkeley, an ancestor of the present earl of Berkeley, who now holds the manor, obtained a grant of a weekly market on Fridays, and an annual fair, both of which are still held. The church is a spacious, handsome fabric, and contains numerous monuments and sepulchral memorials. Here is a free-school, erected in 1385, by Catherine, relict of Thomas, lord Berkeley: also an alms-house for six poor men and six women, built and endowed in 1632, by Hugh Perry, alderman of London, at the charge of 1000*l.*: a like sum was given by sir Jonathan Dawes, sheriff of London, for the relief of the poor. In the population return of the year 1811, the houses in this town were enumerated as 217, the inhabitants as 1527; the latter are chiefly employed in the clothing manufacture, which is carried on to a considerable extent in the town and its vicinity: one factory only, called New Mill, employs under its roof about 200 men, women, and children. Spanish wool alone is manufactured at this place, and is employed for the weaving of broad-cloth and kerseymere.—Rudge's History of Gloucestershire, 2 vols. 8vo. 1803. Beauties of England and Wales, vol. v. Gloucestershire, by J. Britton and E. W. Brayley, 1804.

WOTYECROW, a town of Poland, in the palatinate of Lublin; 12 miles W.S.W. of Lublin.

WOTZLERSDORF, a town of Austria; 10 miles W. of Zitzersdorf.

WOURICHEM. See **WORCUM**.

WOVEN STOCKINGS. See **STOCKING**.

WOUGHS, in *Mines*, are the walls or sides sometimes of hard stones, and sometimes soft; when soft, the miners say they are rotten: these are the bounds of an entry. Betwixt them all sorts of earth, stones, and ore lie; or, as philosophers say, grow.

WOULD, or **WELD**, among *Dyers*. See **WELD**, and *DYER's Weed*.

WOULD, in *Agriculture*, a term applied in some cases to signify an open uninclosed tract of country.

WOULD Land, that which remains in the state and condition of would. There is much of this sort of land in many counties and districts of this country which might be still greatly improved and converted to far better purposes than at present, by simply inclosing them and turning them into a state of proper and suitable cultivation. This has been already done with large tracts in Yorkshire and Gloucestershire to very great benefit, and the same may be the case with many others in different places. See **WASTE Land**.

WOULDS, a term applied by some writers on husbandry to crops of the woad kind. See **WOAD**.

WOULDING. See **WOOLDING**.

WOULMARA, in *Geography*, a town of Bengal; 28 miles S. of Midnapour.

WOUNDS, in *Surgery*, constitute the most ancient and important branch of it, accidental injuries of this kind having in all probability preceded the existence of many of the diseases to which mankind are now liable. The turbulent and enterprising spirit of the earliest generations soon produced wars, and the effusion of human blood; and even the natural habits of every people, in a state of inferior civilization, would conduce to the receipt of wounds, since the chase,

by which food was so commonly procured, would itself cause many accidental hurts. Surgeons usually define a wound to be a solution of continuity, or a division of the soft parts, more or less recently produced, commonly attended with a greater or lesser degree of hemorrhage, and almost always occasioned by an external mechanical cause.

There are some chirurgical writers who make objections to defining a wound to be a *recent* and *bleeding* division of the soft parts, and M. Richerand is one of this number. He disapproves of these terms, because a wound, when long in healing, and accompanied with suppuration, cannot admit of such a definition. And he observes, that writers who have defined a wound in this way, have been obliged to call every suppurating wound, if only of three days' standing, an ulcer, which he conceives to be altogether absurd. The epithet *bleeding*, he contends, is not applicable in a general definition of wounds, since gun-shot wounds are not ordinarily followed by an effusion of blood from the divided parts. *Nosographie Chir.* tom. i. p. 2. edit. 4.

It must be acknowledged, that there is considerable difficulty in fixing the precise period when a wound should cease to be so denominated, and take the appellation of an ulcer. The wound, after several important surgical operations, is sometimes a month or two before it is entirely healed; yet, generally speaking, as long as there is a prospect of a cure within a reasonable length of time, and the cicatrization does proceed, though slowly, surgeons mostly still call the suppurating breach of continuity a wound, and not an ulcer. When, however, a wound is very long kept from healing by injudicious applications, constitutional causes, attacks of hospital gangrene, debility, &c. the case, we think, is most commonly regarded rather as a sore, or ulcer, than as a wound. An ulcer, strictly so called, does indeed seem to imply a breach of continuity arising from the process termed *ulceration*, or *ulcerative absorption*, in which a chasm, or loss of substance, is actually produced in the part by the action of the absorbent vessels. (See **ULCERATION**, and **ULCER**.) This process is also concerned in the production of every sore which is the consequence of a burn; for though parts may be at once killed, and converted into eschars by the fire itself, yet the separation of such deadened parts, or sloughs, so as to leave an ulcer behind, is the result of a process, in which the absorbents of the adjoining living surface remove the particles of matter, which form the connection between those parts which are killed and those which are alive.

In the perusal of Richerand's sentiments, who has betrayed so much delicacy and so many scruples about the admission of definitions, and who is at the same time the author of a modern system of physiology, we confess that we were rather surprised to find him insinuating upon burns, and the apertures by which abscesses spontaneously burst, being wounds, and not ulcers. In fact, he seems to regard the formation of a breach of continuity, in these cases, as entirely the result of physical and mechanical causes, and not as the consequence of a vital process, in which the action of the absorbent vessels has a very considerable share.

With respect to the propriety of the epithet *bleeding*, in the definition of a wound, there cannot be any real objection to it in a general sense; for although a wound does not bleed when in a suppurating state, yet it has almost always done so on the first occurrence of the injury. Even the generality of gun-shot wounds, though it may not be their usual nature to bleed much, commonly pour out some blood.

We have stated, that wounds are produced by external mechanical causes. There are, however, exceptions to this remark;

remark; for it sometimes happens that breaches of continuity, both in the soft and hard parts, are caused by the violent action of the muscles. Thus, the patella and os brachii are occasionally fractured by the powerful contraction of the muscles; and the muscles either tear themselves asunder, or rupture the tendons with which they are connected. Sometimes, also, the sharp point of a broken bone wounds the superincumbent integuments, and changes the case into a compound fracture. Here we see the cause is mechanical, but yet not of an external kind, as in ordinary examples.

Wounds are divided by the writers on surgery into several kinds, the distinctions being founded either upon the sort of weapon with which the injury was inflicted; or upon the circumstance of a venomous matter having been inserted into the part; or, lastly, upon the particular situation of the wound, and the nature of the wounded parts themselves. Hence we have *cuts, incisions, or incised wounds*, which are such as 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, gangrene, and other bad consequences, than in the generality of other species of wounds. Incised wounds also may usually be healed with greater quickness and facility than other wounds, which are accompanied with more or less contusion and laceration: the surgeon has only to prevent the solution of continuity from gaping, or, in other words, he has simply to bring the opposite sides of the wound into contact with each other, and keep them in this state a few hours, and they will unite and grow together.

Another class of wounds are *flabs, or punctured wounds*, made by the thrust of pointed weapons, like bayonets, lances, swords, daggers, &c. and also by the accidental and forcible introduction of considerable thorns, large nails, &c. into the flesh. These wounds frequently penetrate to a great depth, so as to injure large blood-vessels, viscera, and other organs of importance; and as they are generally inflicted with much force and violence, the parts suffer more injury than what would result from their simple division. It also deserves notice, that a great number of the weapons, or instruments, by which punctured wounds are occasioned, increase materially in diameter from the point towards their other extremity; and hence, when they penetrate far, they must force the fibres asunder like a wedge, and cause a serious degree of stretching and contusion. It is on this account that 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 very unfavourable symptoms. The opening which the point of such a weapon makes is quite inadequate for the passage of the thicker part of it, which can only enter by forcibly dilating, stretching, and otherwise injuring the fibres of the wounded flesh.

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 interesting and common injuries denominated *gun-shot wounds*. Many bites rank also as contused and lacerated wounds. In short, every solution of continuity, which is suddenly produced in the soft parts by a blunt instrument, or weapon which has neither a sharp point nor edge, must be a contused, lacerated wound.

Poisoned wounds are those which are complicated with the introduction of a venomous matter, or fluid, into the part.

Thus the stings and bites of a variety of insects afford us examples of poisoned wounds; but a more serious and dangerous instance, which we meet with in this climate, is seen in the cuts accidentally received in the dissection of putrid bodies, or in handling instruments infected with any irritating venomous matter; as sometimes happens to the surgeon in the performance of operations on gangrenous limbs, and in the application of dressings to venereal and other infectious ulcers. The most dangerous, however, of all the poisoned wounds, which ever occur in this kingdom, are those resulting from the bite of the viper, and from the bites of rabid animals, particularly the dog and cat. See HYDROPHOBIA.

Wounds are farther divided by surgical writers into *wounds of the head, wounds of the face, wounds of the throat, wounds of the chest or thorax, wounds of the belly or abdomen, wounds of the limbs or extremities, wounds of the arteries, wounds of the veins, &c. &c.*

Wounds may likewise be universally referred to two other general classes, *viz. 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 re-unite 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 common simple wound. The differences of complicated wounds must, therefore, be very numerous, as they depend upon many incidental circumstances, the principal of which, however, 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, the presence of foreign bodies or of a virus in the part, loss of substance, the attack of hospital gangrene, &c. See ULCER.

All large or deep wounds are attended with more or less symptomatic fever. It usually comes on, as Dr. Thomson observes, at a period varying from sixteen to thirty-six hours after the infliction of the injury. Its occurrence is indicated by an increased warmth of the skin; by increase in the frequency, and generally also in the strength of the action of the heart and arteries; by anxiety, thirst, and by the suppression of the powers of digestion. The symptomatic fever from wounds is generally of the inflammatory character; and it even sometimes happens that a very high degree of symptomatic fever occurs in debilitated constitutions, and in persons who have lost a considerable quantity of blood. In these cases, the frequency of the pulse, however, is more remarkable than its strength, and the fever which occurs seems to resemble more an asthenic fever than it does one that is truly inflammatory. 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. Thomson's Lectures, &c. p. 292.

We shall now proceed to offer a general description of the several kinds of wounds, and the manner of treating them; and then notice the wounds of particular parts, and the surgical measures which seem best calculated to promote their cure. As, however, *wounds of the head*, comprehending its external coverings, and the cranium and brain, form the subjects of articles already published, these cases will not fall under consideration in the subsequent columns, the reader being referred for information concerning them to

COMPRESSION, CONCUSSION, EXTRAVASATION, HEAD, *Injuries of*, and TREPANNING.

Of Cuts or incised Wounds.—Sharp-edged instruments may produce a division of the parts upon which they act, altogether on the principle of direct pressure; in which case, they may be regarded as operating in the manner of a wedge. In other instances, they both press and saw at the same time, and then the solution of continuity is made with more facility, and carried to a greater depth, because the fibres are elongated in the direction in which the instrument saws, as well as in that in which it presses.

In whatever way a cutting instrument operates, several consequences result from the division of the parts. 1st, An effusion of blood from the divided vessels. 2dly, Pain, arising from the division of nerves. 3dly, A gaping of the wound, or separation of its edges from each other.

Anatomy teaches us, that almost every part of the body is furnished with a considerable number of blood-vessels, which indeed exist in such myriads, that it is impossible to prick the skin with the point of the most minute needle, without opening one or more ramifications of vessels containing blood. But this effect always happens in a still greater and more remarkable degree, when the division, caused by a sharp-edged instrument, is at all extensive.

If the wounded vessels are of small size, the blood issues from them only in moderate quantity; but when they are large, the hemorrhage is more copious, and it may be so rapid as to prove almost instantly fatal. Many of the phenomena of hemorrhage have been already considered in another place (see HEMORRHAGE); and, on this account, we shall not have occasion now to travel over the whole of that interesting topic again. There are, however, certain parts of the subject which must fall under consideration in the course of this article; and in mentioning them, we shall take the opportunity of noticing a few ingenious suggestions, which have been made since the period when the above-mentioned article was written, and which, when further investigated, may lead to very important improvements in the treatment of wounds.

It has been stated, that hemorrhage is one of the circumstances which render wounds complicated; yet it is to be understood, that when the bleeding is not so considerable as to hinder the union of the parts, and a further effusion of blood can be prevented by the very same pressure which is necessary to promote this union, the case is always regarded as a simple wound. Such is that which is produced by the operation for the harelip, &c.

The same experiment which demonstrates the presence of blood-vessels in every situation, namely, pricking any part of the body with a needle, proves also that filaments of the nerves are found every where, and at every point; for the slightest prick of the skin occasions pain, and pain cannot happen except where there are nerves. But wounds are observed to be attended with a pain, which is more or less acute, according to the kind of cutting instrument with which they are inflicted, the extent of the division, and especially according as the wounded person happens or not to be in expectation of the receipt of the injury. A patient, on whom an operation is to be performed, turns his whole attention to the effect which the use of the knife will produce upon his feelings, and he suffers a great deal; but if an incision be made when not expected, or a soldier be wounded in the heat of battle, the injury is sometimes not perceived till the bleeding attracts notice.

Immediately a part is divided with a cutting instrument, the edges of the wound separate more or less distantly from each other, and the injury presents a gaping appearance.

This is an occurrence which is owing to several causes, necessary to be understood by every surgeon who is desirous of knowing the best mode of obviating it.

The first cause of the separation of the lips of a wound from each other is, no doubt, the thickness of the instrument with which the solution of continuity is made. A cutting instrument, acting like a wedge, must unavoidably separate the parts between which it enters; but if this were the only cause, the gaping of a wound would be very inconsiderable, since the blades of most cutting weapons are extremely thin. We find, however, that the opposite surfaces of many wounds are drawn away from each other several inches, and the causes to which the phenomenon is to be ascribed are the elasticity and contractile nature of the divided parts; sometimes one of these properties operating singly, sometimes both of them together in the same wound.

Elasticity is a quality which belongs to all animal substances, and it is inherent in them even after they have been deprived of life; but it does not prevail in an equal degree in every texture. Thus, the gaping of a wound depending upon this cause varies very considerably, according to the nature of the divided parts. The edges of an incision made in the skin become widely drawn asunder, because the integuments are endued with great elasticity. The cellular membrane, when cut, gapes very little, because it is less elastic. The muscles also are not remarkably elastic; yet wounds of them, especially transverse wounds, always have their opposite sides separated a vast distance from each other: but this is a circumstance which is owing not altogether to the elasticity of the parts, but partly to their contractile powers.

The separation of the edges of a wound is not always in proportion to the elasticity of the wounded part; it is likewise proportioned to the tension of this part at the very moment of the injury. An exceedingly simple experiment proves the truth of this observation: if the skin which covers the knee be divided transversely in the dead subject, while the leg is bent upon the thigh, and another similar incision be made in the other knee, while the leg is extended, the separation which happens between the edges of the division will be found to be much greater in the first than in the second example.

The contractile power, or irritability, which is a peculiar property of muscular fibres, and by virtue of which they tend continually to shorten themselves, is the most powerful cause of the separation which occurs between the opposite sides of a transverse wound of any muscle. The separation thus produced is the greater in proportion as the cut muscular fibres are longer, inasmuch as the contraction of which the muscles are capable, by reason of their contractile power, is itself in a ratio to the length of the muscular fibres. Thus, as Boyer observes, if two muscles be divided transversely, the fibres of one of which are three times as long as those of the other, the separation which takes place between the edges of the wound of the former will be three times as great as what follows, between the sides of the division made in the latter.

The force with which the separation is produced by the contractile power of the muscles, is not in proportion to the length of the muscular fibres, but to their quantity. Each muscular fibre being regarded as a separate distinct power, it is obvious, that the more these powers are multiplied, the greater must be the effect resulting from their action.

It appears also, that in addition to the first contraction of a divided muscle, a secondary and increased contraction of the part may be excited, when it is exposed and irritated.

From what has been stated, it seems then that in wounds of parts destitute of contractile properties, as the skin, cellular membrane, ligaments, fasciæ, &c. their elasticity is the only cause of such wounds gaping, or of the separation which happens between the opposite surfaces of the injury; but that in muscular wounds the separation is the effect both of the contractile and elastic powers of the part. Hence, as we have already observed, the separation is greater the more tense the muscle is at the instant when the wound is inflicted.

“The edges of every incised wound (says professor Thomson) are more or less retracted, or drawn from each other, and this generally in proportion to the size of the wound, and the nature of the parts upon which it is inflicted. The different soft textures of which the human body is composed are more or less elastic, and are in the healthy condition of the body kept in a certain degree of tension. When the fibres, therefore, of any of these textures are divided, they recede from each other; those of skin farther than those of cellular membrane, and those of muscle farther than those of skin. The fibres of muscle contract most of all. The extremities of a divided artery recede considerably from each other; the veins less than the arteries, and the nerves probably less than the veins. To oppose this contraction of divided parts by suitable means, is one of the main objects which the surgeon proposes to himself in the cure of wounds; for the retraction of the edges of wounds from each other always prevents re-union by the first intention, and very often retards it for a long time by the second.” See Thomson’s Lectures on Inflammation, p. 280; also *UNION by the First Intention.*

The prognosis of wounds made with a cutting instrument varies according to the extent and depth of the division, the nature of the injured parts, and the circumstances which attend the accident. Deep large wounds are more dangerous and more difficult to cure than those which only interest the skin. Wounds, accompanied with injury of considerable vessels or nerves, are more or less dangerous, according to the magnitude or number of those vessels or nerves. Simple wounds, in which the only indication is to bring the divided parts together, so that they may re-unite, are the most favourable cases of all. On the other hand, complicated wounds are more or less hazardous, according to the particular nature of the complication. In the prognosis of wounds also, we must not forget to take into consideration the patient’s age, his kind of constitution, and the diseases under which he may labour. Generally speaking, the most dangerous examples of incised wounds are those which are made about the throat by persons who attempt to destroy themselves. Here there are so many large blood-vessels, nerves, and other parts of great importance, that deep incised wounds too often prove fatal, either immediately, or in the course of a few days. Sometimes the patient opens the carotid artery, and perishes of hemorrhage on the spot, before any assistance can be rendered. In other instances, he divides some of the principal branches of the external carotid, and after losing a great deal of blood he faints, and the hemorrhage spontaneously ceases for a time. The fainting indeed is often the very thing which saves his life, by checking the effusion of blood until a surgeon arrives; who ties the vessels as soon as they begin to bleed again. Cut wounds of the extremities, when such arteries as the femoral and brachial are injured, may also suddenly destroy the patient, by the great quantity of blood which is sometimes lost before the arrival of surgical assistance.

A surgeon, called to a recent cut or incised wound, has

three objects which he should endeavour to accomplish without the least delay.

The first, and that which requires his immediate interference, is the bleeding, which must be checked, or the patient may lose his life in a few minutes.

The second is the removal of all extraneous matter, foreign bodies, &c. from the cavity of the wound.

The third is to bring the opposite surfaces of the wound into even contact, and to adopt proper measures for keeping them in this position, until they have grown together again.

1. *Hæmorrhage.*—For an explanation of the means which nature employs in the suppression of bleeding from divided arteries, as well as for an account of the best surgical measures for promoting this object, and a detail of numerous observations on the principles by which the conduct of the surgeon should be regulated in the use of the ligature, we beg to refer to the articles *HEMORRHAGE* and *LIGATURE.*

In the present place we shall briefly notice how the surgeon ought to act in cases of incised wounds, accompanied with hemorrhage, without passing over, however, a few things which have been suggested since the above-mentioned articles were written.

It has been stated, that in every wound the bleeding is the thing which demands the earliest attention; because if loss of blood be not prevented without delay, the patient will frequently die in the course of a few seconds, or minutes. Every other consideration may be deferred; but when large vessels are injured, they must be immediately secured, or else the sudden death of the patient will leave the surgeon no opportunity of exhibiting his skill and usefulness in other matters connected with the treatment.

It is not, however, every bleeding which is thus serious and alarming; for the slightest and most superficial cuts are always attended with some effusion of blood. When the divided vessels are of inferior size, the bleeding soon spontaneously ceases, and no surgical measures need be taken on this particular account. When the wounded vessels are even somewhat larger, and their situation is favourable for compression with a bandage, it is often advisable to close the wound, and apply a compress and roller, instead of having recourse to ligatures, which always produce irritation, suppuration, and an obstacle to the union of that part of the wound in which they lie. Yet, let the surgeon, before he determines to trust to pressure, be well assured, that the bleeding can be thus perfectly and safely commanded without the employment of ligatures; for by the failure of compression, hemorrhage has often been renewed from time to time, and many a life been lost. We therefore wish it to be distinctly understood, that in almost all cases of considerable bleeding, the patient will not be safe unless the vessels be tied, and that the only exceptions are a few instances in which the bleeding arteries can be effectually compressed against a subjacent bone, and are not of very large size. In all other examples, tying the bleeding vessels is the only safe mode of proceeding. When the artery is of large diameter, and its mouth can be readily seen, the most proper instrument for taking hold of it is a pair of arterial forceps. With this instrument, the end of the vessel is to be drawn out a little way from the surrounding flesh, in order that a ligature may be put round it without the inclusion of any other parts, which would be unnecessary, painful, and on several accounts disadvantageous. In applying the ligature, the surgeon must take care to pull its two ends in such a manner that the noose will not rise above the mouth of the vessel; and, for the purpose of altering the direction of the force

force employed in drawing the ligature, the ends of the thumbs are found most convenient. When the bleeding arteries are not very large and distinct, they are generally taken up with a tenaculum; and of late years a double tenaculum, the points of which shut together, like the blades of a pair of forceps, has been occasionally used, and we have heard some well-informed surgeons speak highly of the invention, which we believe was originally made by professor Asfalini, an ingenious surgeon at Milan, in Italy.

The ligatures having been applied, one end of each is to be cut off close to the knot, in order to diminish the quantity of extraneous matter in the wound.

When a large artery, like the brachial or femoral, is opened, but not cut through, it often happens that the surgeon cannot get at it without making a dilatation of the wound, and bringing the wounded part of the vessel more fairly into view. In cases of this description, the first duty of the practitioner is to compress the artery above the wound, and apply a tourniquet. Thus he will put an immediate stop to the bleeding; but if he omit this essential step, the vessel will continue to bleed so profusely and rapidly, that in the inevitable obscurity and confusion thence resulting, the patient may actually lose his life before the vessel is secured. When, however, a tourniquet has been applied, the surgeon can examine the wound, and search for the artery with much greater success, as now the state of things is no longer concealed under a continual stream of blood.

As soon as the wounded portion of the artery is discovered, it ought not to be extensively dissected and separated from its surrounding connections in order to let the surgeon pass his finger under it. This mode of proceeding is now acknowledged by some of the best surgeons to be unnecessary and injurious; and it will be quite sufficient to separate the artery sufficiently to pass an eye-probe or aneurismal needle under it, with which a double ligature is to be drawn beneath it. The probe or needle having been cut off, one ligature is then to be tied above the aperture in the artery, and the other below it. Were only a single ligature applied above the wound in the artery, the bleeding would still be kept up, because the blood passes into the lower continuation of the vessel through numerous large anastomoses, in a quantity that is truly surprising.

The principles which should guide the surgeon in the use of the ligature, were not known until the late Dr. Jones published his valuable treatise on hemorrhage. As an able surgeon has observed, "he has banished the use of thick and broad threads, of tapes, of reserve ligatures, of cylinders of cork and wood, linen compresses, and all the contrivances, which, employed as a security against bleeding, only served to multiply the chances of its occurrence." Lawrence in *Medico-Chir. Transf.* vol. vi. p. 162.

In the article *SURGERY*, we have noticed the method of cutting off both ends of the ligature close to the knot on the face of the stump, with a view of lessening the quantity of extraneous matter in the wound, and promoting a complete union of the divided parts, without any suppuration. The period of the first invention of this method appears uncertain. Mr. Hennen, who seems to have been the first who adopted the method in the army, had it suggested to him in 1813 by a Mr. Hume, as the practice of some American naval surgeon; and he has since found that it had been done in Scotland 16 years before the above year. Dr. Ferguson also saw the practice adopted in Sweden as early as the peace of Amiens. Mr. Hennen mentions 34 amputations, in which this treatment was followed by suc-

cess. His accounts are highly in favour of the method. See Hennen's *Military Surgery*, p. 189, &c.

This plan has been tried by Mr. Lawrence: "The method I have adopted (says this gentleman) consists in tying the vessels with *fine silk ligatures*, and cutting off the ends as close to the knot as is consistent with its security. Thus the foreign matter is reduced to the insignificant quantity, which forms the noose actually surrounding the vessel, and the knot by which that noose is fastened. Of the silk which I commonly employ, a portion sufficient to tie a large artery, when the ends are cut off, weighs between $\frac{1}{100}$ th and $\frac{1}{80}$ th of a grain: a similar portion of the thickest kind I have tried weighs $\frac{1}{100}$ th of a grain, and of the slenderest $\frac{1}{1000}$ th."

Mr. Lawrence states, that the kind of silk twist which is commonly known in the shops by the name of dentist's silk, and which is used in making fishing-lines, is the strongest material, in proportion to its size, and therefore the best calculated for our purpose, which requires considerable force in drawing the thread tight enough to divide the fibrous and internal coats of the arteries. This twist is rendered very hard and stiff by means of gum, which may be removed by boiling it in soap and water; but the twist then loses a part of its strength. The stoutest twist which Mr. Lawrence has used, is a very small thread compared with ligatures made of inkle. The quantity of such a thread necessary for the noose and knot on the iliac artery weighs $\frac{1}{100}$ th of a grain; or, if the gum has been removed, about $\frac{1}{100}$ th. But the finest twist kept in the silk shops is strong enough in its hard state for any surgical purpose; and the noose and knot, according to Mr. Lawrence's statement, would not weigh $\frac{1}{100}$ th of a grain.

It farther appears from the report of this gentleman on the subject, that there is no danger of these ligatures cutting completely through the vessel, as some surgeons have apprehended; and that although he has not yet ascertained what becomes of the pieces of ligature after the wound is united, he has never seen abscess nor any other bad symptom occasioned by them. At the time when Mr. Lawrence wrote, he had employed this method of securing the arteries in ten or eleven amputations, in six operations on the breast, and in the removal of two testicles. The cases all did well, excepting a man who lost his thigh, and who died of an affection of the lungs. See Lawrence on a *New Method of tying the Arteries in Aneurism, Amputation, &c.* in *Medico-Chir. Transf.* vol. vi. p. 156, &c.

It merits notice, however, that the proposal of cutting off the ends of the ligatures close to the artery has not received the universal approbation of surgeons; and, in particular, Mr. Guthrie, of London, and Mr. Cross, of Norwich, have urged objections against the practice. The former gentleman, at the same time, does not entirely condemn the method, but merely argues that it is liable to inconveniences, when adopted in wounds which are to be healed by the first intention. See *Obs. on Gun-shot Wounds of the Extremities*, p. 93.

Professor Scarpa also, whose experiments lead him to prefer large ligatures and intervening substances between them and the vessel, must be numbered amongst those who disapprove of the new plan. Like all his writings, the memoir which he has recently published respecting the ligature of arteries is highly interesting, and drawn up with the greatest candour.

Mr. Cross, of Norwich, is more decidedly adverse to this new practice; and he founds his objections chiefly upon some

Some experiments which were made upon animals, and which, he conceives, justify the following conclusions :

First, If the wounds do not unite by the first intention, the ligatures may escape with the discharge, without any inconvenience.

Secondly, If common ligatures of twine are cut short, the wound may unite over them, and they may be found in abscesses after an interval of many weeks.

Thirdly, If the finest darning's silk be employed in the same way, the wound uniting over it, the ligature may be detached from the vessel, and remain buried in an abscess, where it will be found at different periods, from one to seven months; and this may happen whether the vessel be firmly compressed with a single ligature, or divided between two ligatures, so as to imitate the circumstances under which vessels are tied after operations.

Fourthly, If Indian silk, fine as hair, be put round a vessel, so as to diminish its diameter, or to effect its obliteration, by just compressing its sides together, it may remain in this situation without exciting abscess, or producing any inconvenience. The ligature may be thus applied to compress an artery for the cure of aneurism; but not to secure vessels divided in operations. If a thin ligature be drawn sufficiently tight upon a vessel on the face of a stump to be secure, Mr. Crofs is persuaded, that the extremity of the vessel, which becomes insulated as it were, must die. (See London Med. Repository, vol. vii. p. 363.) In one case of amputation also, in which the practice was tried, the stump was long in healing, and several small abscesses repeatedly formed.

On the other hand, we must take into consideration, that M. Delpech, of Montpellier, has practised it to a considerable extent for several years past, without any inconvenience. M. Roux has also tried the plan in three operations on the breast; the cases did well, and no ill consequences arose from the presence of the bits of thread under the cicatrix. See Relation d'un Voyage fait à Londres en 1814, ou Parallele de la Chirurgie Angloise avec la Chirurgie Française; Paris, 1815, p. 134—136.

Mr. Hennen, in answer to Mr. Guthrie, also observes, that in the cases where it was tried at Bilbao, "neither pain, heat, nor tumour, febrile exacerbation, nor formation of pus, could be fairly traced to the short cut ligatures, which would not in all human probability as readily have succeeded to the ligatures usually employed; while, on the contrary, the progress of healing has been sensibly more rapid where they have been used." *Obs. on Military Surgery*, p. 193.

Since Mr. Lawrence communicated to the Medical and Surgical Society of London the description of a "New Method of tying the Arteries in Aneurism, Amputation, and other Surgical Operations," he has constantly employed the method therein proposed, both in St. Bartholomew's hospital and in private practice; and, as he informs us, he has now tried it in many operations of almost every description. "The general result of my experience is (says he), that this plan, by diminishing irritation and inflammation, and simplifying the process of dressing, very materially promotes the comfort of the patient, and the convenience of the surgeon, while it has not produced ill consequences or any unpleasant effect in the cases which have come under my own observation.

"I have found in my own practice, what has been confirmed by others, who have communicated to me the result of their experience, that the small knots of silk generally separate early, and come away with the discharge; that where the integuments have united by the first intention, the

ligatures often come out rather later, with very trifling supuration, and no painful inflammation; and that, in some instances, they remain quietly in the part.

"In two or three instances, I have been told that the ligatures seemed to have caused irritation and pain. These were amputations; and we are accustomed to see effects, quite as considerable as were alluded to here, produced by the state of the bone and other causes, where the ordinary method of securing the arteries is practised; so that I could not, on close inquiry, find any reason to ascribe what was complained of to the use of the silk ligatures, and the practice of cutting off their ends close to the knots." *Medico-Chir. Transf.* vol. viii. p. 490.

Mr. Lawrence contends, that under some circumstances the method will be attended with peculiar advantages, as in crowded military hospitals, where the destructive hospital gangrene either exists, or may make its appearance. Every measure tending to accelerate the union of wounds, whether after operations or under other circumstances, is of great importance in averting the probability of this calamitous occurrence.

This mode of cutting off both ends of the ligature close to the knot has now been successfully applied to operations for aneurism. Mr. Lawrence has himself found it answer his expectations; and we learn, that Mr. Carwardine, of Thaxted, tied the femoral artery with a small silk ligature, in a case of popliteal aneurism, and cut off the ends close to the knot. The wound united entirely by the first intention, not a particle of pus having been formed at any time; and it continued perfectly found at the distance of some months from the operation. *Op. cit.* p. 492.

If this practice prove generally beneficial in operations for aneurism, there can be no doubt it will also be advantageous in other cases, in which the surgeon is called upon to cut down to and take up punctured or partially divided arteries in accidental wounds.

Although doubts are yet entertained by some practitioners, whether this new method of applying ligatures is entitled to praise and imitation, all surgeons are unanimous about the propriety of lessening as much as possible the quantity of extraneous bodies in wounds: hence, even they who disapprove of cutting off both ends of the ligature close to the knot, sanction and adopt the practice of cutting off one-half of each ligature close to the vessel, as the other portion will suffice for the removal of the knot and noose as soon as they are detached from the tied artery. When the wound is brought together, the ligatures are to lie in the nearest interspaces left between the plasters.

2. *Of the Removal of Clots of Blood, extraneous Substances, foreign Bodies, &c. from the Wound.*—This forms the second indication to which the attention of the surgeon is particularly required, when he is first called to an incised wound. It is, indeed, an object of very material importance, because if it be not attended to, the wound may be brought together as nicely, as accurately, and as skilfully as possible, and every thing look well in the beginning; yet that desirable event, union by the first intention, will not follow, but instead of it a severe degree of pain, considerable swelling of the circumference of the injury, extensive redness, and suppuration and abscesses. All these severe and untoward consequences arise from the irritation produced by the presence of foreign bodies in wounds; and as an incised wound can generally be examined with the utmost facility, and made properly clean, without putting the patient to much pain, the neglect on the part of the surgeon becomes the more blameable. In other deep, narrow, lacerated wounds, and in many gun-shot injuries, it is often difficult at first to ascertain

tain whether there are extraneous substances in the flesh or not; but in open incised wounds no such difficulty and obscurity prevail, and the practitioner who closes them, without having assured himself that they are perfectly free from all extraneous matter, betrays either the most supine negligence, or an utter ignorance of his professional duty. It is true an incised wound made with a clean, sharp instrument, which has not broken, can obviously have no foreign bodies in it. But very considerable and dangerous cuts are often produced by glass, china, &c. which are apt to break at the moment, and leave some of their fragments in the part. Sometimes also the weapon with which the wound is made is unclean, and occasionally dirt, gravel, &c. get into the wound, in consequence of the patient falling upon the ground at the time when he receives the injury. We shall merely repeat, that as extraneous bodies operate as an irritation to all kinds of wounds, the surgeon ought to take care to remove them immediately the bleeding vessels have been secured.

Mr. John Hunter believed, that blood retaining the living principle was rather an useful substance in the union of wounds than otherwise; and he only considered blood, which had been deprived of this principle by long exposure, the effect of styptics, &c. as hurtful, when left on the surface of the wound. Yet this is a doctrine which is by no means sanctioned by the approbation of the best modern practitioners, all of whom are decidedly of opinion, that leaving any blood upon the surface of a recent wound, when the opposite surfaces of such wound are to be brought into contact, is disadvantageous, retarding the cure, and rendering union by the first intention less certain. The presence of blood in the cavity of the wound, indeed, must have the effect of producing a greater or lesser separation of those surfaces, which ought strictly to touch each other; and we decidedly believe, that the practice of freeing wounds as much as possible from clots of blood may be successfully defended both upon theoretical and practical principles.

3. *Union of the Wound, Dressings, &c.*—We have said, that when the surgeon has stopped the bleeding, removed extraneous substances, and properly cleaned the wound, the next indication is to bring the opposite sides of the injury into contact with each other, and keep them quietly and steadily in this position until they have grown together again. Wounds are healed by two processes; viz. by one, in which pus is produced, and granulations and new skin are formed; and by another, in which, if it perfectly and universally succeed, no suppuration whatsoever takes place. The latter, when it can be practised, is always the most desirable, because it is not only the quickest means of cure, but also the most perfect; the part being covered by the old original skin, which is always stronger and less disposed to ulceration than what is new formed. Surgeons have termed this way of healing wounds *Union by the First Intention*, (see these last words,) or *Adhesion*; and Mr. Hunter named the process by which it, together with many other analogous effects, was accomplished in the animal body, the *Adhesive Inflammation*. See INFLAMMATION.

The great recommendations of union by the first intention are, celerity of cure, the diminution of the pain and inflammation arising from the exposure of raw surfaces, freedom from the inconveniences of suppuration, the prevention of the deformity, which would otherwise result from a large cicatrix, and the greater permanency and soundness of the cure, for the reasons above stated.

The strong tendency which divided parts of the animal body have to grow together, when kept a certain time in contact with each other, is an important fact, of which the

moderns have taken much more advantage than the ancients. There are even cases and experiments on record in support of the opinion, that it is not entirely impossible for parts entirely detached from the rest of the body to become united again, if quickly replaced. In the article *UNION by the First Intention*, we have noticed the interesting experiments made by Duhamel and Mr. Hunter. The researches of the latter celebrated philosopher brought to light several very curious and instructive facts. He proved that the testicles of a cock, when removed and introduced into the abdomen of a hen, contracted a vascular connection with the surface of the viscera, and lived. He ascertained, that a sound tooth might be transplanted from its socket, and acquire an union to the alveolar process of another person. He also cut off the spurs of a young cock, and found that they might be made to unite to its comb, or that of another cock, and grow in such situation. The possibility of this species of union shews how strong the disposition of the fresh surfaces of an incised wound must be to grow together; particularly when it is considered, that in the foregoing and in some of the following instances, there can be on one side no assistance given to the union, as the part entirely separated from the rest of the body is hardly able to do more than preserve its own living principle, and (as Mr. Hunter expresses himself) accept of union.

The following observations on this subject are taken from professor J. Thomson's excellent book on inflammation: "Besides those examples that are seen in the transplantation of the teeth, it must be confessed, that instances of re-union among parts which had been entirely separated are very rare in the human body; so rare, indeed, that most practitioners still treat with disbelief and ridicule the few instances which have been put upon record. But the different facts which have been learned respecting the transplantation of the teeth, together with the experiments of Duhamel and Mr. Hunter, prove indisputably the possibility of parts being re-united which have been completely separated from the animal system to which they belonged, and in which the circulation of the blood must necessarily have ceased for a time. There is nothing therefore in the nature of the fact recorded, that can justify us, I conceive, (says Dr. Thomson,) in doubting the veracity of those, by whom similar instances of re-union between other parts of the body have been related.

"That practitioners have generally failed in effecting this re-union, is frankly acknowledged by those who have related cases so very extraordinary. I shall mention to you (continues this author) a few of those rare cases, and leave it to your own judgment to deduce from them the conclusions, which the characters of the authors by whom they are related, and the nature of the facts themselves which they relate, may seem to you to warrant.

"The first example of this kind which I find distinctly recorded is by Phiorovant, in the 54th page of his second book of the *Secrets of Surgery*: 'In that time, when I was in Africa, there happened a strange affair: a certain gentleman, a Spaniard, that was called Il Signior Andreas Gutiero, of the age of twenty-nine years, upon a time walked in the field, and fell at words with a soldier, and began to draw. The soldier seeing that, struck him with the left-hand, and cut off his nose, and there it fell down in the sand. I then happened to stand by, and took it up, and pissed thereon to wash away the sand, and dressed it with our balsamo artificiato, and bound it up, and so left it to remain eight or ten days, thinking that it would have come to matter; nevertheless when I did unbind it, I found it fast conglutinated, and then I dressed it only once more, and he was perfectly whole, so that all Naples did wonder thereat, as is well

known; for the said Signior Andreas doth live, and can testify the same."

"Blegny, in his *Zodiacus Medico-Gallicus*, for the month of March, 1680, mentions a case, in which a nose that had been cut off with a fabre was replaced by a military surgeon of the name of Winsault, and in which a perfect re-union was obtained, he affirms, by the use of stitches, and of agglutinating plasters.

"A third case of the same kind is related by Garengot, at the 55th page of the third volume of his *Operations of Surgery*. 'In the month of September, 1724, a soldier of the regiment of Conti, coming out of L'Epée Royale from an inn, at the corner of the street Deux-Ecus, was attacked by one of his comrades, and in the struggle had his nose bitten off, so as to remove almost all the cartilaginous part. His adversary perceiving that he had a bit of flesh in his mouth, spat it into the gutter, and endeavoured to crush it by trampling upon it. The soldier, who on his part was not less spirited, took up the end of his nose, and threw it into the shop of M. Galin, a brother-practitioner of mine, till he should run after his adversary. During this time, M. Galin examined the nose that had been thrown into his shop, and as it was covered with dirt, he washed it at the well. The soldier returning to be dressed, M. Galin washed his wound and face, which was covered with blood, with a little warm wine, and then put the extremity of the nose into this liquor to heat it a little. Having in this manner cleansed the wound, M. Galin now put the nose into its natural situation, and retained it there by means of an agglutinating plaster and bandage. Next day the re-union appeared to be taking place; and on the fourth day, I myself dressed him with M. Galin, and saw that the extremity of the nose was perfectly re-united and cicatrized.'

"These (says professor Thomson) are the only cases which I have been able to find distinctly stated of the re-union of a nose which had been completely cut off. This event, from analogy, we have reason to believe is possible, and nothing short of a contrary testimony in the instances I have related could justify us, I conceive, in denying the truth of the fact."

Dr. Thomson then details a case, extracted from vol. xxxiii. of the *Journal de Médecine*, where the point of a finger which had been cut off was re-united by M. Bossu, surgeon at Arras. Dr. Thomson also mentions, that he has been informed by different persons entitled to credit of a considerable number of cases similar to the preceding, in which the points of fingers and toes completely separated were afterwards re-united.

Although it must be acknowledged that the foregoing cases of the union of parts completely severed from the body are uncommon, the same observation does not apply to instances in which the detached part still retains a partial and slight connection with the rest of the body, by means perhaps of only a few fibres or little bit of skin. "Many cases," says Dr. Thomson, "are upon record, and many more have been observed, in which parts have re-united, which were divided all to a very small portion of cutis,—a portion so small that it is not easy to conceive that any effectual circulation could be carried on through it; and in these cases it deserves to be remarked, that it was generally the nose, or the extremities of the fingers and toes, which re-united, after having been separated and replaced. I have seen two examples of the re-union of the nose, where it was almost entirely separated. In one of them it adhered only by the skin of one of the alæ, and in the other chiefly by the septum. Arcæus mentions a case in which the nose, with most of the upper jaw, was so separated as to hang

down upon the chin, and yet a re-union was effected. A case is mentioned by Lombard, in which the nose, nearly cut off and unreplaced for some hours in winter, was made to re-adhere by stitching and proper dressings. Another case of the same kind occurred to Loubet." (*Lectures on Inflammation*, p. 243.) In the *Dictionary of Practical Surgery*, an instance is mentioned, in which an ear that had been completely separated from the head, with the exception of a small bit of skin, was united again with the aid of a future; and Dr. Thomson has himself seen portions of the little toe and little finger, after being nearly cut off, successfully re-united.

The knowledge of all these facts cannot but prove useful in the practice of surgery, inasmuch as it teaches the practitioner to attempt the union of parts, under circumstances which would otherwise appear entirely hopeless and discouraging.

In promoting union by the first intention, surgery is merely to officiate as the handmaid of nature. There are only two indications to be fulfilled: the first is to bring the edges of the wound into reciprocal contact, and keep them so; the other is to avert the access of immoderate inflammation, by which the agglutination of the wound would certainly be prevented. The first object is accomplished by a proper position of the wounded part, by bandages, by adhesive plaster, and by futures. The second is fulfilled by a strict observance of the antiphlogistic regimen, and particularly by avoiding every kind of motion and disturbance of the wound. The rest is the work of nature.

The position of the part is to be regulated on the principle of relaxing the wounded integuments and muscles. If the extensor muscles are injured, the joints which they move ought to be placed in an extended posture; if the flexor muscles are wounded, the limb is to be bent. When the integuments alone are cut, the same posture which relaxes the muscles situated immediately beneath the wound also serves in general to relax the skin. In transverse wounds of muscular fibres, it is astonishing what immense effect the observance of a proper posture produces. This is never to be neglected, whatever may be the other means adopted.

Bandages may frequently be made to contribute very essentially to keeping the sides of wounds duly in contact with each other. This is strikingly illustrated in cases of harelip, where we see that the opposite edges of the fissure may be brought forward so as to touch, and be maintained in this position by the simple use of compresses and a bandage. Such was the mode of treatment preferred by M. Louis after the operation for the harelip, and were it not for the greater convenience and certainty of the twisted future, it is the plan to which surgeons would yet have recourse. (See HARELIP.) The *uniting*, or, as it was formerly named, the *incarnative bandage*, is one which operates in keeping the opposite surfaces of wounds accurately applied to each other, so that the opportunity may be afforded for them to unite and grow together again. The common uniting bandage can only be used in wounds which take a direction corresponding to the length of the body or limbs, and which are situated where a bandage can be employed with convenience and effect. It consists of a double-headed roller, having a slit between the two heads. The slit must be sufficiently large to allow one head of the roller to pass through it with facility. The wound having had the requisite dressings put on it, the surgeon is to take one head of the roller in each hand, and apply the bandage to that part of the limb which is opposite the wound. One head of the roller is then to be brought round, so as to bring the slit over the breach of continuity. The other

head is then to be brought round in the opposite direction, and passed through the slit. The bandage is now to be drawn moderately tight, and its two heads being carried round the limb again, the same artifice is to be repeated. A sufficient number of turns of the roller must be made to cover the whole length of the limb.

When the wound is deep, it is recommended to place small longitudinal compresses beneath the roller, at a little distance from the edges of the wound.

As the uniting bandage can only be made use of for longitudinal wounds, which never have a considerable tendency to gape, nothing can be more absurd than the application of it with immoderate tightness. By such cruel and injudicious practice, many a limb and life have been lost; for, if the bandage be very tight on its first application, what a dangerous constriction of the limb or part must follow, when the swelling, necessarily arising from the wound, has had time to come on. It is thus that insufferable pain, gangrene, and sphacelus, have frequently been brought on, when, if the part had been simply dressed and left unconfined, every thing would have gone on most favourably. It is right to state, however, that modern surgeons are not partial to the uniting bandage, and we freely declare our conviction, that it is a means which may very well be dispensed with in practice.

If it has any advantages, they consist in its having more power than the adhesive plaster alone to maintain the opposite sides of deep wounds in contact, and in its acting without the irritation frequently arising from the application of resinous substances to the skin. It is not, however, exempt from serious inconveniences. Its total concealment of the wound, its lying in irregular folds, so as to create an uneven cicatrix, and the pressure and constriction attending its use, &c. might be mentioned. (See First Lines of Surgery, p. 68. edit. 3.) So little is the uniting bandage now employed, that although we have seen some thousands of wounds, we have not noticed its use in a single instance during the last twelve or fifteen years. When pressure can be made to assist the other dressings, surgeons almost always resort to compresses and a simple roller. In a few particular cases, in which the limb would be too much disturbed by the application and removal of a common roller, the eighteen-tailed bandage is to be preferred. See BANDAGE, and FRACTURE of the Thigh.

Adhesive plaster may be said to be the most common means employed in the practice of surgery for bringing the edges of wounds together. When used for this purpose, it was sometimes technically called by the old surgeons the *dry future*, in opposition to futures strictly so named, which are usually made with a needle, and are invariably attended with a degree of bleeding. It was at one time supposed, that adhesive plaster could be of no material use, except in superficial wounds of the skin. It is true, that adhesive plaster has no direct effect in bringing together the sides of a deep muscular wound; yet we ought to recollect, that by drawing the integuments over the deeper part of the injury, it at once prevents the continuance of the exposed state of the cut surfaces, under which suppuration would unavoidably follow. Nor does the use of adhesive plaster hinder recourse to other measures more calculated to bring the opposite surfaces of the deeper part of the wound into contact, such as the observance of a proper position, and the use of compresses and a bandage. It is also an error to suppose that adhesive plaster cannot be used in situations where hair grows, or where it will soon become wet. If the part be well shaved, and perfectly dried at first, the application will not become loose so soon as to

prove ineffectual. In such instances, the plaster should be very fresh, and its quality may be made rather more adhesive than in ordinary cases.

Adhesive plaster is generally applied in strips, between every two of which an interspace is recommended to be left, for the purpose of allowing any discharge to escape. To bring the edges of the wound effectually together, and at the same time to leave a little room for the exit of the discharge, are the objects to which we ought particularly to attend in the employment of adhesive plaster: hence, when the strips are broad, it is not unfrequent to cut out an oval piece of each strip just where it crosses the line of the wound. Equal parts of the *emplastrum plumbi*, and of the *emplastrum resinæ*, form the composition generally used in this country for adhesive plaster. They are melted over a slow fire and well mixed together, after which they are spread upon linen with a warm spatula.

Sutures, or *Stitches*, are of several kinds, but the only one which is now usually employed in the cure of wounds is the *interrupted future*. The *quilled future* is rarely used at present, though it was formerly much in favour, and is not yet passed over by systematic writers. As a description of these futures has been given in a separate article (see SUTURE), we shall not repeat the particulars of the manner of making them. The *twisted future* is not unfrequently preferred for holding together the edges of cuts in the face, where the parts are liable to be in almost constant motion, and where the avoidance of the disfigurement of a large scar is peculiarly desirable. This is the future which is always employed in the cure of the *Harelip*, in which article a description of it will be found. These, and a future called *gastroraphe*, which will be noticed in speaking of *wounds of the abdomen*, are all the kinds of futures which are ever employed by modern practitioners. The *glover's future*, or *continued stitch*, is now nearly rejected from practice, and confined to the sewing up of dead bodies; a purpose for which it is better adapted than for the union of any wound in a living subject.

On the subject of the propriety and advantage of using futures, as a means of keeping the sides of wounds in contact, much diversity of sentiment has prevailed. Some surgeons, especially M. Pibrac and M. Louis, have urgently recommended their entire discontinuance; and their observations are accompanied by facts which must have considerable weight. Their opinions and arguments, we acknowledge, have constantly influenced us in practice; and if we do not join in the sentiment, that futures ought to be entirely abandoned, we at least believe that they are still a great deal too much used. M. Pibrac and M. Louis, however, are entitled to great praise for having lessened the employment of needles in surgery; and though there are few instances in which the utility of futures appears to be confirmed by experience, there are many others in which the practice is altogether unnecessary and injudicious. "The practice of stitching," says Dr. Thomson, "is undoubtedly much less followed at present than in any former period of the surgical art; and unless in superficial wounds, where we wish to heal by the first intention, or in wounds where (as in those of the abdomen) it is necessary that the edges should not be allowed to separate from each other, the use of stitches may be, in most instances, advantageously superseded by adhesive plasters and proper bandaging. It is by limiting the use of futures, not by proscribing them altogether, that the surgeon is likely to derive advantage from the employment of means so powerful." (See Lectures on Inflammation, p. 287.) There are certainly hardly any two surgeons who think exactly alike about the cases in which futures

utures are truly beneficial or not. Thus we do not admit that they ought to be used as frequently as the remarks of the above distinguished professor would warrant; and the majority of superficial wounds, in which union by the first intention is indicated, certainly, so far from being benefited by futures, would be injured. Further observations, however, on this subject will be found in the article SUTURE.

When futures are judged necessary, their operation is always assisted by the application of suitable compresses and a bandage, the good effects to be derived from position of the part being also not neglected. The stitches ought in general to be removed between the third and seventh day; or if they are allowed to remain longer, or even in some cases so long, they excite inflammation, and sometimes ulceration.

Such then are the means which surgeons adopt for keeping the opposite surfaces of wounds in contact, until an union has taken place. When the parts grow together again without any suppuration, the mode of cure, as we have already explained, is well known to surgeons by the term *union by the first intention*. Of the nature of this process, and of the way in which a connection is established again between the parts which have been divided, we have endeavoured to give some account in a preceding volume; we shall not, therefore, expatiate on the subject. See UNION *by the First Intention*.

The first plasters and dressings applied with a view of bringing about this desirable method of cure, should be allowed to continue at least three or four days, unless any untoward symptoms, such as excessive pain, the renewal of hemorrhage, &c. indicate the contrary. The severity of the pain is sometimes owing to the future, sometimes to the immoderate tightness of the roller, and occasionally to there being extraneous substances yet lodged in the wound.

When too much inflammation is apprehended, the bandage should never be tight; and wetting it with cold water may be of use by keeping the parts cool. Perfect quietude, and the usual antiphlogistic remedies, are also not to be omitted. The old plan of covering the dressings with thick woollen rollers, caps, and large masses of tow, has now gone very much out of fashion, as being inconsistent with those principles which are recognized by every scientific surgeon as best calculated to avert and lessen inflammation.

When the first dressings are removed, the surgeon often finds union by the first intention only accomplished at certain parts of the injury; and the connection, even there, still requires further support. However, when the wound is dressed again, it is generally unnecessary to apply as many strips of adhesive plaster as were employed in the first instance. Their number may be gradually lessened at each future dressing. The futures, if there be any, should also be now withdrawn, as they will do no more good, and their continued presence may excite irritation and do harm. Suffice it to add, that throughout the subsequent treatment the rest of the dressings should be light, simple, and un-irritating.

Of the Cure of Wounds by Granulations, &c.—We remarked, that wounds are healed by two processes, one of which was not attended with the formation of pus, was the quickest and most perfect in its effects, and was called *union by the first intention*, or *adhesion*. The other process now requires description. "When, in the treatment of a wound," says professor Thomson, "the re-union by adhesion, or by the first intention, has either not been attempted at all, or, if attempted, has failed, nature brings about a cure by that slower and more complicated operation, which we now denominate the *process of granulation*; a process

termed (as we have already remarked) by Galen *re-union by the second intention*. By many of the older surgeons, this mode of healing wounds is described by the appellation of *lysarcosis*, or *concarnation*, terms perhaps less liable to objection than that of granulation, which, in strict propriety, is a term expressive of only one of the stages of this mode of re-union, and which, of course, in order to avoid all ambiguity in the language we employ, ought not to have been used as a general term for the whole. In re-union by the second intention, the edges of the wound swell and inflame more than in the process by adhesion; but, as in that process, so in this, a layer of coagulable or organizable lymph is thrown out upon the divided surfaces. This layer is soon penetrated by blood-vessels, and, like the intermedium in adhesions, (see UNION *by the First Intention*,) becomes an organized and living substance. So far these modes of re-union are similar; but in a short time after this layer of coagulable lymph has been thrown out upon the open and exposed surfaces of a wound, there is thrown out also upon the same surfaces a quantity of pus, or the matter of sores. This fluid, like the coagulable lymph, is the immediate product of a change induced in the action of the capillary vessels existing in the divided substances of the wound, a change by which they seem to become secreting instead of circulating tubes. The action by which pus is formed is now denominated *suppuration*: the old surgeons gave to it the name of *digestion*. See SUPPURATION.

"When the surfaces of the wound have been severely injured, or when the patient is of a bad habit of body, a greater or less portion of these surfaces losing its vitality, separates from the remaining sound part, and comes away in the form of a slough. The older surgeons, who are most minutely accurate in the descriptions which they have left us of diseased appearances, call this the *deterision* or *mundification* of the wound: the surgeons of the present day, *sloughing*, or the *separation of the slough*. See the article GANGRENE.

"In the healthy conditions of the body, and when the edges of the wound are uninjured, the smooth surface of the layer of coagulable lymph which covers the bottom of the wound is, in the course of a few days after the suppuration has taken place, raised into a number of small eminences, like grains or papillæ. These little eminences are termed *granulations*, and their formation in the healing of wounds, the *process of granulation*. By the older surgeons, this step, in the process of re-union by the second intention, was commonly termed *incarnation*, or *concarnation*, terms expressive of the formation of a portion of new flesh." See GRANULATION.

"On the surfaces of these granulations, but most frequently on the edges of the wound next to the skin, small white specks appear; the quantity of pus which is secreted gradually diminishes, and the blueish-white specks, by continuing to increase in number and size, come at last to cover the surface of the wound. On examination, the surface of the wound will now be found to be covered by a kind of new skin and cuticle. The formation of this new skin has long been denominated the *process of cicatrization*, and the process of re-union by the second intention being now fully accomplished, the wound is said to be completely *cicatrized*." Thomson's Lectures, p. 288.

The re-union of a wound by the first intention is the work of one, two, or three days; while re-union by the second intention always requires a period of several days, and sometimes in diseased constitutions, or parts which have been much injured, of months, or of years. Thomson, p. 290.

As the same well-informed writer remarks in another place,

place, most wounds admit of being healed partly by adhesion, and partly by the process of granulation. We have very good examples of this in the wounds made in amputation of the extremities, and in the extirpation of the mamma, or of other large tumours. We know, or at least we have reason in these instances from the first to suspect, that the whole of the wound will not heal by adhesion; but we are ignorant whether a large or a small portion will be healed by that process; and accordingly, we at first proceed in the dressing of such wounds, as if we expected or intended that the whole should heal by adhesion. We bring the edges of the wound together by adhesive straps, or stitches, and support these by proper bandaging. The adhesive straps are of great use even in those wounds in which it is impossible to bring the edges at first into contact. They bring and retain the edges near each other; they diminish the size of the wound; they keep surfaces in contact which have a disposition to adhere; and ultimately, by the gradual elongation of the old skin, even where the distances between the sides is at first considerable, they bring the separated edges to unite together. *Op. cit.* p. 293.

With respect, however, to the particular mode of dressing wounds which are to heal by granulations, it seems unnecessary to enter into any long detail in the present place; because the treatment is to be conducted on the very same principles which apply to sores, and which we have so fully explained in another article. See *ULCER*.

We shall conclude this section of the subject of wounds with a few useful rules, which professor Thomson recommends to be observed in the dressing and examination of these cases.

In examining or dressing a wound, we ought never to give the patient more pain from our modes of procedure, or methods of dressing, than is absolutely necessary for his present good and future security. For instance, we ought never to probe a wound where probing can be of no use; and we should be contented to remain ignorant of those things, the knowledge of which could only gratify an idle curiosity.

Another good rule is, to have all the fresh dressings perfectly ready before the removal of those which have been previously applied. A sponge and warm water, adhesive straps, pledgets of various ointments, lint, compresses, and bandages, are to be at hand, and not to be sought for at the very moment when they are required for use.

As in many instances the removal of the dressings, and the application of others, take up a considerable time, we ought carefully to reflect what the position is which will be most easy to the patient, and at the same time most convenient to the surgeon.

When the bandage, adhesive plaster, and other dressings, have become hard and dry, and glued together, and to the surrounding skin by blood, or other discharge from the wound, the surgeon should soften and loosen the applications by wetting them a sufficient length of time with warm water, which is to be pressed out of a sponge upon them, a basin being held below the part for the reception of the water as it falls off the dressings. This duty is of much importance in saving the patient from a great deal of agony, which the abrupt removal of the adherent dressings would produce.

In removing the dressings which are under the bandage, we must be careful that the ligatures are not entangled, and that we do not pull them forcibly away. Pulling at the ligatures during the first dressings, as professor Thomson remarks, always occasions pain; and if, in removing the

dressings, the threads be incautiously torn off, a greater or less degree of hemorrhage may be produced, and much distress, if not danger, occasioned. To avoid this accident, therefore, we ought always to search for the ligatures previous to the removal of the dressings, and to separate them from these dressings when they adhere, as they most frequently do.

Having formed and separated the ligatures, we must next proceed to remove the adhesive straps by which the edges of the wound are more immediately kept in contact. It mostly happens, that a greater or less portion of these straps is loosened from the surface of the wound by the fluid which exudes from it. This is the part, therefore, from which (says Dr. Thomson) we should first proceed to separate these straps, because it is here that the edges of the wound may be supposed to recede farthest from each other, and the pus to have found the freest exit. But the manner in which the remaining adhering portion of strap is to be separated, is not, as may first appear, a matter of indifference. There is but one way in which it can be properly taken off, though it is one which is often neglected in practice. In removing these straps, we are always to lay hold of them by the ends, first by the one, and then by the other end, and to pull them off in the direction of the wound, taking care never to raise the end of the strap much above the level of the skin, nor to continue to pull by the end we hold, after we have separated it as far as the wound. Were the straps pulled off in a direction from and not towards the wound, the edges of the injury to which they adhere would be drawn away from each other; the slight adhesions which have formed between one side of the wound and the other would be torn, and the process of re-union disturbed and retarded. If we raise the end of the strap, we also tear the edge of the wound from the subjacent parts to which it adheres.

Another good piece of advice given by professor Thomson is, that only one adhesive strap, or at most two, should be removed at once; and the part from which it has been removed being carefully wiped with the sponge, and dried with a soft linen cloth, a fresh strap is always to be applied before another is removed. It is from inattention to this rule that we see the surfaces of wounds and sores daily torn open at each dressing, merely by the weight of the parts which have just been united.

The edges of the wound, particularly if it be a large one, should always be held together by an assistant during the time of dressing.

When there are several wounds, only one is to be opened and dressed at a time, so that all unnecessary exposure of the parts may be avoided.

At each dressing care must be taken to prevent lodgments of matter, by placing the compresses and straps of plaster in the manner best adapted to press upon and obliterate any cavity in which the pus has a tendency to accumulate.

A pledget of some mild cerate or ointment is usually applied over the adhesive plaster, and its size should exceed that of the wound. It is preferable to dry lint, which becomes adherent, troublesome to remove, and often conceals and sticks to the ligatures. If lint be necessary, it may be employed over the pledget. Modern surgeons, however, are far more sparing of thick masses of lint, tow, flannel-rollers, &c. than their predecessors, as we have previously explained.

On the subject of bandages we shall here add nothing to what has been already stated in the foregoing section of this article.

In the dressing of wounds, says Dr. Thomson, particu-
larly

larly in hospital practice, where frequent change of linen is not at all times obtainable, it is of great consequence to the comfort of the patient, and to the general health and welfare of the other patients, that every attention should be paid to cleanliness, and that every thing filthy and offensive should be removed from the room or ward as quickly as possible. Above all things, care must be taken not to let the matter touch the bed-clothes.

The frequency of dressing must be regulated by the quantity and quality of the discharge from the wound, by the situation of the injury, by the climate and season of the year, by the effects which the renewal of the dressings seems to produce, and by the feelings, and sometimes the wishes of the patient.

During the long-continued discharge of pus from many wounds, the strength of the patient must be supported, and granulation and cicatrization promoted by nourishing diet and proper cordials. The most disagreeable, and unfortunately not an unfrequent termination of large wounds, is the formation of unhealthy granulations, attended with a general wasting of the body and hectic fever. See Thomson's Lectures on Inflammation, p. 294, &c.

Of punctured Wounds, or Stabs.—Punctured wounds are not only dangerous on account of their frequently extending to a considerable depth, and injuring important blood-vessels, nerves, and viscera, but they are also dangerous, inasmuch as they often give rise to violent and extensive degrees of inflammation. It is not uncommon to see formidable collections of matter follow wounds of this description, especially when the instrument with which they have been made has penetrated any aponeurosis, or fascia. Stabs and all other punctures are not simple divisions of the fibres of the body; they are attended with more or less contusion and laceration, according to the particular form of the weapon, and the degree of violence with which the thrust has been made. Hence there is not the same propensity to union by the first intention, which we observe in wounds made with sharp-edged instruments; and when ligamentous expansions are amongst the parts injured, it is not uncommon to see a train of severe local and constitutional symptoms follow. Immense agitation of the nervous system sometimes ensues upon the infliction of a punctured wound; and it has been generally attributed to the injury of tendons or nerves. This doctrine, however, is now almost quite exploded, as surgeons so frequently see nerves and tendons wounded, without the occurrence of great constitutional disorder. The truth is, that alarming nervous symptoms do not follow punctured wounds in perhaps more than five cases out of a hundred, in which tendons and nerves of some size are actually injured. It cannot, therefore, be so much the injury of these parts, as other circumstances attending stabs, which are the cause of the severe indisposition sometimes suddenly induced by such wounds. When they extend deeply, the consequences of the injury of large blood-vessels and viscera will often account for the great constitutional disorder, without having any recourse to doctrines like the foregoing.

Punctured wounds are frequently followed by the formation of deeply-seated abscesses and sinuses, and hence the cure is often difficult, and sometimes it cannot be effected till after a considerable time.

With respect to the treatment of punctured wounds, we may observe, that in this part of practice erroneous suppositions have commonly led to many serious abuses. The unqualified idea, that the severe consequences of most punctured wounds are, in a great measure, owing to the narrowness of their orifices, has induced numerous surgeons to

practise indiscriminately deep and extensive incisions, for the purpose of rendering their external communication considerably wider. To have constantly in view the conversion of such injuries into simple incised wounds has always been a maxim strongly insisted upon, and set forth as the reason of the above method of treatment. The doctrine even occasioned the frequent dilatation of punctured wounds by the still more absurd and cruel means, the employment of tents.

Certainly, if the notion were true, that an important punctured wound, such as the stab of a bayonet, is actually changed into a wound partaking of the mild nature of an incision, by the mere enlargement of its orifice, the corresponding practice would be highly commendable, however painful it might be. But the fact is otherwise: the rough violence done to the fibres of the body by the generality of stabs is little likely to be suddenly removed by an additional violence—the enlargement of the wound. Nor can the distance to which a punctured wound frequently penetrates, and the number and nature of the parts injured by it, be at all altered by such a proceeding. These, which are the grand causes of the collections of matter which often take place in the cases under consideration, must exist, whether the mouth and canal of the wound be enlarged or not. The time when incisions are proper is, when there are foreign bodies to be removed, abscesses to be opened, or sinuses to be divided. To make painful incisions sooner than they can answer any end is both injudicious and hurtful. They are sometimes rendered quite unnecessary by the union of the wound throughout its whole extent, without the least suppuration.

It is true, as is observed in a modern publication, that making a free incision in the early stage of these cases seems a reasonable method of preventing the formation of sinuses, by preventing the confinement of matter; and were sinuses an inevitable consequence of all punctured wounds, for which no incisions are practised at the moment of their occurrence, it would undoubtedly be unpardonable to omit them. Fair, however, as this reason for the use of the knife may appear to some practitioners, it is only superficially plausible, and a very little reflection soon detects its want of real solidity. Under what circumstances do sinuses form? Do they not form only when there is some cause existing to prevent the healing of an abscess? This cause may either be the indirect way in which the abscess communicates externally, so that the pus does not readily escape; or it may be the presence of some foreign body, or dead portion of bone; or, lastly, it may be an indisposition of the inner surface of the abscess to form granulations arising from its long duration, but removable by laying open the cavity. Thus it becomes manifest, that the occurrence of suppuration in punctured wounds is only followed by sinuses, when the surgeon neglects to procure a free issue for the matter after its accumulation, or when he neglects to remove any extraneous bodies. But as dilating the wound at first can only tend to augment the inflammation, and render the suppuration more extensive; and as likewise the new incision may heal up by the first intention before it has answered any purpose at all; the practice should never be adopted in these cases, except for the direct objects of giving a free exit to matter already collected, and of being able to remove extraneous bodies palpably lodged in the part. We shall once more repeat, that it is an erroneous idea to suppose the narrowness of punctured wounds so principal a cause of the bad symptoms with which they are often attended, that the treatment ought invariably to aim at its removal.

Recent punctured wounds have absurdly had the same plan of treatment applied to them as old and callous fistulæ. Setons and stimulating injections, which in the latter case sometimes act beneficially, by exciting such inflammation as is productive of the effusion of coagulating lymph, and of the granulating process, can never prove serviceable when the indication is to moderate an inflammation which is disposed to rise too high. The counter-opening, which must be formed in adopting the use of the seton, is also an objection; and though French authors have given us accounts of their having drawn their setons across patients' chests, in cases of stabs, they will find some difficulty in making the practice seem unattended with harm, much less productive of good. The candid and judicious surgical reader should not always think a plan of treatment right because the patient gets well; for there is an essential difference between a cure promoted by really useful means and an escape, notwithstanding the employment of hurtful ones.

For our own part, we cannot see what good can ever possibly arise from the use of setons in cases of punctured wounds. Will a seton promote the discharge of foreign bodies, if any happen to be present? By occupying the external openings of the wound, will it not be more likely to prevent it? In fact, will it not itself act with all the inconveniences and irritation of an extraneous substance in the wound? Besides, let it be recollected, that punctured wounds are rarely accompanied with the lodgment of foreign bodies. Is a seton a likely means of diminishing the immoderate pain, swelling, and extensive suppuration so often attending punctured wounds? It will undoubtedly prevent the external openings from healing too soon; but cannot this object be effected in a better way? In most instances where much matter is collected, and where the suppuration is likely to last a long while, in consequence of exfoliations, there will be no chance of the sinus healing up prematurely; and if such risk should appear probable, it is always easy to maintain an external opening by the daily introduction of a probe into the sinus, and a small dossil of lint into its orifice. See *First Lines of Surgery*, edit. 3. chap. xvi.

When a surgeon is called to a punctured wound or stab, he may often form some opinion respecting the depth and nature of the injury by examining the weapon with which it was done, and observing how far the blood reaches along the blade from the point, and by attending to the quantity and quality of the fluids which may issue from the external opening. Thus, the escape of chyle or feces will denote that the bowels are injured; the effusion of urine will indicate that the bladder or some part of the urinary organs is wounded; and the flow of much arterial blood will prove that a considerable artery is opened. Wounds of the lungs will also be attended with particular symptoms, as we shall notice in speaking of wounds of the chest. In many instances, however, important viscera and large deep-seated arteries are injured by stabs, and yet no information can at first be deduced respecting what has happened from attention to local symptoms alone. The faintness and great sudden prostration of strength, the faltering, low, and intermitting pulse, the vomiting or coughing up of blood, and the coldness of the extremities, however, are still sufficient evidence that the case is complicated with injury of important organs, and that the patient is in a state of urgent danger. These are matters which will be best understood when we come to the consideration of wounds of the chest and belly, and therefore we shall not dwell upon them at present.

From what has been already stated, the reader must be aware that we do not follow the bulk of surgical writers in recommending the indiscriminate dilatation of the orifices of

punctured wounds; nor do we admit the propriety of using the knife for the purpose of preventing mischief only expected and apprehended, but not actually existing. Whenever we have had an opportunity of attending bayonet or other punctured wounds, unattended with any particular complication, we have always observed nearly the same principles as are now so generally approved of in cases of gun-shot wounds. We have abstained from dilating the orifice of the injury, except when it was necessary either to get at a bleeding artery in the first instance, or to give a freer egress to the discharge in a later stage of the case. We have given the preference to mild, simple, unirritating, and superficial dressings. We have not placed much faith in the utility of enveloping the parts in a tight bandage; but, after applying the first superficial dressings, have usually covered the limb with linen, wet with the lotio plumbi acetatis, or cold water. Whenever a roller was used, it was not with a view of making pressure, but of retaining the dressings. The wound having been dressed, we have then usually put in practice all such means as are generally deemed most efficient in preventing and diminishing inflammation; such as venesection, the exhibition of aperient and saline medicines, low diet, &c. When the pain was very severe in the beginning, we have prescribed opiates, and on the access of much swelling, have always been careful to let the bandage be slack. We believe that, on the whole, the application of superficial dressings and cold washes is mostly the best practice for the first twenty-four hours after the receipt of a punctured wound. But if after this period the pain should appear to increase, and the swelling to become more and more considerable, the surgeon may then remove the bandages, and apply from six to a dozen leeches to the neighbourhood of the wound. He must also substitute for the cold lotion the use of fomentations, and emollient poultices, under which is to be laid over the orifice of the wound a small pledget of spermaceti cerate, or other simple ointment. The poultices and fomentations are to be renewed morning and evening, and the leeches may be repeated, if necessary, three or four times.

By pursuing this antiphlogistic sort of treatment, suppuration may be sometimes entirely prevented, and the formation of large deep abscesses frequently averted. Should extensive collections of matter, however, take place, proper openings are to be then made without delay, either by dilating the original wound, or by making one or more incisions in other places, as may seem most advantageous. The case, in fact, is then to be treated upon the very same principles which are observed in the management of abscesses in general.

Of contused and lacerated Wounds.—The instruments which have the effect of producing what is termed a *contusion*, are either of an ordinary description, such as a cudgel, a stone, &c. or they consist of balls, bullets, and other metallic bodies, which are impelled into the flesh with immense velocity by the explosion of gunpowder. The latter occasion particular kinds of injury, well known by the name of *gun-shot wounds*, which are a class of cases so highly interesting, that although they are strictly only examples of severely contused wounds, surgeons have always found it expedient to treat of them as distinct and peculiar cases. Indeed, when it is recollected how many difficult, intricate, and momentous questions the subject of gun-shot wounds embraces, the necessity of considering it by itself is immediately manifest.

The blunt weapons, or obtuse hard substances, which, being applied with violence to any part of the living body, bruise, rupture, and otherwise hurt the fibres and vessels, may produce two different species of injury. First, they may more or less forcibly compress and crush the parts upon

WOUNDS.

upon which they act, so as to disorder the texture of those organs which are situated under the integuments, without, however, causing any breach of continuity in the skin itself. (This is the case which is usually called a *bruise*, or *contusion*.) Secondly, acting with a certain degree of violence upon the same parts, they may produce a solution of continuity which is named a *contused wound*. The latter effect more commonly follows when the surface of the contusing weapon or body is not very broad. The cases which rank as simple bruises have been described in another volume of this publication, (see *CONTUSION*,) and therefore we shall not detain the reader with any observations upon them in the present place.

The majority of wounds are attended with some degree of contusion. Those which are inflicted by the blunt edge of a sabre, or by the obtuse point of a bayonet or foil, are as much contused wounds as they are punctured ones; and hence, like other contused wounds, they do not often admit of being united by the first intention.

It must be confessed, indeed, that most of the endeavours to re-unite the sides of a contused wound, however skilfully directed, generally fail. An agglutination of the parts at most only takes place at the bottom of the wound, in which situation the flesh has suffered less contusion, the violence having spent itself, as it were, upon those parts upon which it first operated: hence suppuration of the external portion of the wound is mostly unavoidable. Still the attempt at re-union ought to be made; for if only the bottom of the wound should heal by the first intention, it will be a great advantage gained, more especially when the surface of a bone has been exposed and uncovered by the injury. However, in bringing the sides of contused wounds nearer together, the surgeon is not to attempt to do it with the same closeness and accuracy as in the instance of an incised wound. The injured parts would not bear the pressure, and the means requisite for this purpose; and it may be laid down as an established rule that nothing is more hurtful in cases of contused wounds than much pressure, either from strips of adhesive plaster, or a tight roller. Sutures in these cases are also totally unjustifiable; and we think we have seen several examples, in which a rash determination of the surgeon to close large contused wounds by stitches, tight strips of plaster, and bandages, has had no inconsiderable share in bringing on the rapid and fatal gangrene which carried off the patients. When we say, therefore, that a contused wound ought to be closed, and that its opposite surfaces should be brought nearer to each other, in order that the chance of some part of the injury uniting by the first intention may be taken, we do not mean to recommend dragging the parts together by main force, or placing them in a state of constriction. On the contrary, we think that they ought to be left quite unconfined, the adhesive plaster being used very sparingly, with considerable spaces between the strips, and so put on as rather to hold the loose parts together than to press and draw them into contact with each other. The wound then is not to be entirely covered with sticking-plaster, a practice which is hurtful even in incised wounds, but merely a strip applied at particular points, where the application promises to have great effect in hindering the wound from gaping, without producing any dangerous constriction of the parts. That a strip of adhesive plaster may frequently be used with striking advantage in contused and lacerated wounds experience daily proves; and the benefit must surprise us, when we remember that by preventing the wound from gaping in the manner it would otherwise do, we not only afford an opportunity for parts of it to re-unite, but at once diminish an inevitable cause of inflammation and suppuration, *viz.* the exposure of a large raw surface to the air.

Contused and lacerated wounds not only differ from incised wounds in the circumstance of their being more disposed to suppurate, and more difficult to heal by the first intention, they differ also in the particularity of not bleeding much, sometimes even when the largest arteries are lacerated, as must be the case when whole limbs are torn away, in consequence of becoming entangled in different kinds of machinery.

This indisposition to hemorrhage is not altogether a favourable omen, because though the patient runs less chance of bleeding to death in these cases than in cut wounds, yet the very circumstance of the large vessels not pouring out blood evinces that the violence, contusion, and other injury done to the parts, in addition to the mere division of them, must have been excessively severe, and that the dangers of the subsequent inflammation, suppuration, and sloughing of the parts, more than counterbalance the present security from bleeding.

We shall not find, in all the records of surgery, any facts more extraordinary than those which have been published at different periods on the subject of whole limbs being torn away, not only without hemorrhage, but without any other fatal effects. The cases of limbs torn off related by Cheselden, in the *Philosophical Transactions*, by La Motte, in his *Traité des Accouchemens*, by Mr. Carmichael, in the fifth volume of the *Edinb. Med. Commentaries*, and others in the second volume of the *Mém. de l'Acad. de Chirurgie*, are some of the most remarkable.

As far as our observations extend, all lacerated and contused wounds should be treated according to common antiphlogistic principles. When the injury is extensive, and attended with a great deal of contusion, venesection is to be practised, and the oozing of blood from the surface of the wound may be encouraged by the use of fomentations. With respect to dressings, they should always be of a mild un-irritating quality. After lessening, by a strip or two of adhesive plaster, the exposed cavity of the wound, when this is large and the surrounding skin loose, the part may be covered with pledgets of the unguentum cereæ, over which should be laid an emollient poultice. As the first dressings should not be removed for at least 24 or 36 hours, care ought to be taken to put into the poultice a sufficient quantity of sweet oil, to prevent it from becoming soon hard. Afterwards, however, the dressings may be changed once, twice, and even thrice a day, in bad cases, with advantage; for as soon as the sloughs begin to separate, and suppuration to take place, the necessity for changing the dressings and poultices more frequently is self-evident. In severe cases, fomentations may be used at the periods of dressing; and it will be found that nothing is so effectual in relieving the pain arising from the inflammation which has been induced. The employment of leeches also should not be forgotten, as a valuable means of palliating the inflammatory symptoms. Professor Asalini, of Milan, has lately written strongly in praise of the good effects which are produced by the application of cold washes to parts which have received contused wounds (see his *Manuale di Chirurgia*); and we believe the plan is particularly useful in the first instance, when it is a great object to check the increase of extravasated fluids in the surrounding parts. But afterwards we think emollient applications are the best; and, indeed, it may be questioned, whether the employment of cold lotions at first would not sometimes be objectionable, inasmuch as they must tend to stop the oozing of blood from the surface of the wound; a thing which is considered by many surgeons extremely beneficial, and an object which they think ought to be promoted even by the use of fomentations.

ations. This is a point, however, which comparative and unprejudiced experience is alone capable of deciding. If, in cases of lacerated and contused wounds, the surgeon is less frequently, than in incised wounds, called upon to take measures for stopping bleeding immediately after the accident, he finds greater occasion for attending to another important duty, imposed upon him in his professional attendance upon wounded persons in general: we allude to the early removal of all foreign bodies and extraneous substances from the wound. Cuts are usually made with clean sharp instruments; but contused and lacerated wounds often occur in a manner which renders them particularly likely to contain dirt, gravel, bits of glass, porcelain, &c. We have seen one case in which the patient could not use his arm for a twelvemonth, in consequence of some fragments of a broken bottle not having been taken out of a wound of the hand in the first instance. The wound did indeed heal up; but the pieces of glass occasioned so much pain and inconvenience, that the part could not be used. New incisions were unsuccessfully made for their removal, and the fingers were becoming permanently bent and contracted when we last saw the patient. Whether the foreign bodies have been subsequently extracted we know not; but the case deeply impressed us with the importance of always removing extraneous substances while a wound is fresh, and best admits of the requisite examination.

With regard to lacerated wounds, the same practical remarks apply to them which have been offered on the subject of contused wounds; but the prognosis is generally considered as more unfavourable, and in warm climates tetanus is alleged to be a very frequent consequence of these injuries. See TETANUS.

The bites of rabid animals afford examples of a most dangerous description of lacerated and contused wounds, the peril, however, originating not from the mechanical injury itself, but from the case being complicated with the insertion into the wounded part of a poison or virus, the effects of which, when they do occur, almost bid defiance to the power of the medical art. See HYDROPHOBIA.

As soon as the surface of a contused or lacerated wound has thrown off its sloughs, suppurated, became clean, and evinced a tendency to form granulations, the poultices are to be discontinued, and simple dressings employed. These are afterwards to have their quality altered, according to the appearances which the fore may assume; but any further directions respecting the management of the case, after it has arrived at this stage, must be quite superfluous here, as ample instructions will be found in the article ULCER.

Some contused and lacerated wounds would inevitably be followed by the rapid mortification of the limb, and the patient run the greatest risk of losing his life, were amputation not to be performed immediately after the receipt of the injury. These are generally examples in which the soft parts are extensively and deeply wounded, and large blood-vessels and nerves also injured. The size, however, of the wound seems of itself sometimes to be a cause of gangrene; for we remember a brewer's servant, who, when sitting on the fore-part of a dray-cart, met with an injury, by which the skin covering the front of the tibia was torn from the knee to the ankle, and though no other mischief appeared to have been received, the whole limb and even the scrotum rapidly mortified, and the man lost his life. It should be known, that these are cases of what M. Larrey calls traumatic gangrene, in which he and some other modern surgeons conceive that amputation may often be

done with success, though the mortification has not ceased to spread at the time of the operation. (See SURGERY.) This practice had also its advocates in former days; but since the time of Mr. S. Sharp and Mr. Pott, the rule of never attempting amputation before a line of separation has formed between the dead and living parts, has been acknowledged, taught, and respected, in every school of surgery. For an account of the treatment of contused and lacerated wounds which have ended in mortification, the reader must turn to the article GANGRENE.

Of Gun-shot Wounds.—Strictly these cases ought, perhaps, to be classed with other wounds, attended with much contusion and laceration of the parts; but the injuries which are received in modern warfare from the employment of fire-arms are so numerous, complicated, and various, that the subject undoubtedly merits separate consideration. A general description of these accidents, and of the method of treatment, will be found under the head of GUN-SHOT Wounds. Since that article was written, however, so much valuable information has been laid before the public by several distinguished army and navy surgeons, that it becomes necessary for us to avail ourselves of the present opportunity to notice some practical points of the first-rate importance in military surgery.

Amongst the observations on the subject of *Gun-shot Wounds* in a former volume, the reader will find a statement of some of the sentiments which were entertained by the late Mr. Hunter concerning the treatment of these injuries. It will there be found, that this celebrated surgeon, as well as a few other eminent practitioners, was far from being an advocate for immediate amputation, even in cases in which he acknowledged that there was no possibility of ultimately saving the injured limb. It was his opinion, that more patients died when the operation was done early, than when it was performed in a later stage, after inflammation had subsided, and suppuration had been fairly established. Such precepts, however, do not coincide with the results of modern experience; and, as in numerous instances, the decision for amputation or for delay involves the question of life or death, we think that every opportunity ought to be taken of refuting this part of Mr. Hunter's writings.

According to the united observations of all well-informed experienced army surgeons, it may now be set down as an established rule in military surgery, *that in every case in which a limb is so shattered and injured, that no probability of its being finally saved presents itself, amputation ought to be done at once, without any delay.* For nearly the last two hundred years, there have always been some men of talents and experience, who not only recommended, but actually adopted this judicious practice. Du Chesne, who wrote in 1625, advises the performance of amputation in cases of severe injuries of the limbs; and it is worthy of remark, that *he directs the operation to be performed before inflammation and other constitutional symptoms have supervened.* (See *Traité de la Cure générale et particulière des Arceufades*, Paris, 1625, p. 143.) Wiseman, the father of English surgery, not only recommended and practised immediate amputation, but the same thing was not infrequently done by the military surgeons of his time. (*Chirurgical Treatises* by R. Wiseman, 3d edit. London, 1696, p. 410.) The celebrated Le Dran, in his excellent little manual of military surgery, declared himself an advocate for *immediate* amputation in all cases in which that operation from the first appears to be indispensable. (See *Traité ou Réflexions tirées de la Pratique sur les Plaies d'Armes à feu*, Paris, 1737.) Ranby, who was serjeant-surgeon to king George II., entertained opinions similar to those of Le Dran, with regard to

to the advantages and necessity of immediate amputation, whenever the injury is such as to remove all reasonable hope of ultimately saving the limb. See Ranby's Method of treating Gun-shot Wounds, edit. 3. p. 29. London, 1781.

The following account of this interesting subject is principally abstracted from the third edition of Cooper's Dictionary of Practical Surgery, published in the year 1818:— After the battle of Fontenoy, in the year 1756, the Royal Academy of Surgery in France offered a prize for the best dissertation on the gun-shot injuries requiring immediate amputation, and on other cases of the same nature, where the operation, though deemed inevitable, might be delayed. The prize was adjudged to the dissertation of M. Faure, the main object of whose paper was to recommend delaying the operation. The side of the question espoused by M. Faure has found some modern advocates of distinguished talents and celebrity. Suffice it to mention the names of Hunter, Baron Percy, and Lombard. It is, however, only justice to M. Faure to state in this place, that though he regarded immediate amputation as full of danger, he admitted that there were several kinds of injuries of the extremities in which it was indispensably and immediately required. "The enumeration," says Dr. Thomson, "which this author has given of these injuries is more full and distinct than any which had been published before his time; and, what may appear singular, it does not differ in any essential respect from the enumerations given by later writers, who in combating his opinions have represented him as an enemy to amputation in almost all injuries of the extremities." See Report of Observations made in the Military Hospitals in Belgium, p. 169.

Although in France the academy of surgery thought proper to decree the prize to M. Faure, whose doctrine thus received the highest approbation, yet in that country very opposite tenets were set up by some men of distinguished talents and extensive military practice. Thus Le Dran, consulting surgeon to the French army, in his work on gun-shot wounds, published in 1737, expressly states, "that when the amputation of a limb is indispensably necessary in the case of a gun-shot wound, it ought to be done without delay." (Aphorism 9.) M. La Martinière, in particular, wrote some excellent arguments in reply to M. Bilguer; arguments which would do honour to the most accomplished surgeon of the age in which we live. (See Mémoire sur le traitement des plaies d'armes à feu, in Mém. de l'Acad. de Chirurgie, tom. xi. p. 1. edit. in 12mo.) M. Boucher, of Lille, was an advocate for the same side of the question. (See Obs. sur des plaies d'armes à feu, &c. in Mém. de l'Acad. de Chirurgie, tom. v. p. 279, &c. edit. in 12mo.) Schmucker, who was many years surgeon-general to the Prussian armies, published in 1776 an essay on amputation, in which he particularly mentions, that during his stay at Paris in 1738, the surgeons of the Hôtel-Dieu had been in the habit of performing immediate amputation in severe injuries of the extremities. He also declares himself an advocate for operating immediately, in all cases in which amputation from the first appears to be necessary, and insists, in a particular manner, on the increased danger which he had seen arise from the operation during the second period. He gives, as Dr. J. Thomson has observed, a minute and circumstantial enumeration of those injuries, both of the upper and lower extremities, in which he conceived amputation to be necessary, and in many of which he had actually performed it with great success. Schmucker appears to Dr. Thomson to have given a better account than any preceding military surgeon of the injuries of the

thigh; and from the results of his experience, he was led to believe, that *though compound fractures of the lower part of the thigh-bone might, in favourable circumstances, be cured without amputation, yet that this operation is peculiarly necessary in all cases in which the fracture is situated in or above the middle of that bone.* (See *Untersuchung über die Abnehmung der Glieder* von J. L. Schmucker. *Vermischte Chirurgische Schriften*, band i. Berlin, 1785.) With the foregoing high authority we have to join one of not less celebrity, namely, that of M. Larrey, who has proved most convincingly, that when amputation is to be done in cases of gun-shot wounds, nothing is so pernicious as delay. See *Mémoires de Chirurgie Militaire*, tom. ii. p. 451, &c.

The principles inculcated by M. Larrey are, in point of fact, the same as those which were so strenuously insisted upon by Mr. Pott, in his remarks on amputation. Mr. Pott, indeed, was not an army surgeon, and what he says was not particularly designed to apply to military practice, but he has represented, as well as any body can do, the propriety of immediate amputation for injuries, which leave no doubt that such operation cannot be dispensed with.

Mr. John Bell, amongst the moderns, also defended the propriety of early amputation, long before the sentiments of later writers were ever heard of. He distinctly states, that "amputation should, in those cases where the limb is plainly and irrecoverably disordered, be performed upon the spot." (See *Discourses on the Nature, &c. of Wounds*, p. 488. edit. 3.) Indeed, notwithstanding all the modern pretensions to novelty upon this interesting topic, we must acknowledge, with Dr. Thomson, that the evidence in favour of the advantages of immediate amputation has always preponderated over that for delay. See Report of Obs. made in the Military Hospitals in Belgium, p. 225.

The strongest body of evidence upon this matter, however, is adduced by M. Larrey, whose situation at the head of the medical department of the French armies has afforded him most numerous opportunities of judging from actual experience.

"If we are to be told," says he, "that the amputation of a limb is a cruel operation, dangerous in its consequences, and always grievous for the patient, who is thereby mutilated; that, consequently, there is more honour in saving a limb, than in cutting it off with dexterity and success; these arguments may be refuted by answering, that amputation is an operation of necessity, which offers a chance of preservation to the unfortunate, whose death appears certain under any other treatment; and that if any doubt should exist of amputation being absolutely indispensable to the patient's safety, the operation is to be deferred, till nature has declared herself and given a positive indication for it. We are also justified in adding, that this chance of preservation is at the present day much greater than at the epoch of the academy of surgery. We learn from M. Faure, that of about three hundred amputations performed after the battle of Fontenoy, only thirty were followed by success, whilst, on the contrary, says M. Larrey, we have saved more than three-fourths of the patients on whom amputation has been done, and some of whom also had two limbs removed. This improvement is ascribed by M. Larrey, 1st, to our now knowing better how to take advantage of the indication and favourable time for amputating; 2dly, to the dressings being more methodical; 3dly, to the mode of operating being more simple, less painful, and more expeditious, than that formerly in vogue."

To the preceding authorities against delaying amputation, in cases of gun-shot wounds requiring such operation, we have to add that of Mr. Guthrie, deputy inspector of military

tary hospitals, whose opportunities of observation, during the late war in Spain, were particularly extensive. Mr. Guthrie, however, does not recommend amputation to be done immediately, if the patient be particularly depressed by the shock of the injury directly after its receipt. "If a soldier, at the end of two, four, or six hours after the injury, has recovered from the general constitutional alarm occasioned by the blow, his pulse becomes regular and good, his stomach easy, he is less agitated, his countenance revives, and he begins to feel pain, stiffness, and uneasiness in the part: he will now undergo the operation with the greatest advantage, and if he bears it well, of which there will be little doubt, he will recover in the proportion of nine cases out of ten, in any operation on the upper extremity, or below the middle of the thigh, &c. If, on the contrary, the operation be performed before the constitution has recovered itself, to a certain degree, from the alarm it has sustained, the additional injury will most probably be more than he can bear, and he will gradually sink under it and die." (On Gun-shot Wounds, p. 24. London, 1815.) As far as our experience goes, however, all delay is improper when the necessity of amputation is undoubted, at least all delay beyond the short period, during which the faintness immediately arising from the injury usually lasts. In the campaign in Holland, in 1814, the most successful amputations were those done in the field hospitals directly after the arrival of the patients. On this point, however, hardly any difference of sentiment prevails, because all naval and military surgeons agree, and mean, that amputation is not to be performed till the faintness and depression of the powers of life, directly following the wound, have been sufficiently obviated for the patient to bear the operation well. The seeming difference, therefore, on this matter, between Mr. Guthrie and Mr. Hutchison, is not very material. (See Hutchison's Practical Obs. on Surgery, 1817.) It appears from some returns, collected by Mr. Guthrie, that in the peninsula, the comparative loss, in secondary or delayed operations, and in primary or immediate amputations, was as follow:

	Secondary.	Primary.
Upper extremities	- - 12 to	1
Lower extremities	- - 3 to	1

The great success attending amputation on the field of battle was also convincingly proved after the battle of Toulouse. Here of 47 immediate amputations, 38 were cured, while of the 51 delayed operations, on that occasion, 21 had fatal terminations. P. 42—44.

Lastly, we have to notice, amongst the advocates for immediate amputation, Mr. Hennen, a surgeon employed with our army in Spain and the Netherlands. "The question," says he, "of immediate amputation has of late attracted an attention, which its great importance naturally calls forth; but it appears to me, that an idea has been impressed upon the minds of practitioners in civil life, that doubts as to the propriety of the practice had existed among the British army surgeons. For my own part, I have never known any differences of opinion on the point. In books, it is true, it has been most amply discussed before the present generation were in existence; but in British practice all doubts have long been at an end. It is but justice to British surgeons, both naval and military, to declare, that immediate amputation is neither a new doctrine nor a recent practice among them, &c." See Hennen's Obs. on some important Points in the Practice of Military Surgery, p. 45. Edinb. 1818.

If, however, military surgeons have definitively settled

the great question, that in all cases in which a limb cannot be saved, the sooner amputation is done the better, they neither have, nor probably will ever be able positively to settle and define the exact degrees of injury which, in every instance, ought to be followed by putting the former rule in practice. In fact, no part of surgery is more difficult, than that in which the question of the possibility or impossibility of saving wounded limbs is submitted to the judgment and determination of the practitioner. Some injuries, indeed, are so bad, that no difficulty in making a decision is experienced; but there are other cases, in which the damage done to the parts is less violent and extensive, and in which the exact degree of mischief is not at first apparent. There are, in short, numerous doubtful examples, in which the formation of a right judgment is equally difficult and important.

The annexed remarks will convey the sentiments of some of the latest writers on the second great question in military surgery. What are the exact cases in which amputation should be done immediately, and what are those in which the operation may be deferred?

Of Cases in which Amputation should be done immediately.—First case. A limb carried away by a cannon-ball, or the explosion of a howitzer, or bomb, requires amputation without any loss of time: the least delay puts the patient's life in danger.

In this case, the necessity of the practice is inculcated by M. Faure himself, as well as by Schmucker, Richter, Larrey, Dr. Thomson, and every modern writer upon gun-shot wounds.

If the operation be not speedily done, pain commences, fever occurs, and the functions become disordered; the irritation then increases, and convulsive motions take place. If the patient should not be a victim to these first symptoms (continues Larrey), gangrene of the stump is occasioned, the fatal consequences of which it is extremely difficult to prevent.

Second case. When a body propelled by gunpowder strikes a limb, in such a manner as to smash the bones, violently contuse, lacerate, and deeply tear away the soft parts, amputation ought to be immediately performed. If this measure be neglected, all the injured parts will soon be seized with gangrene: and besides, as M. Larrey has explained, the accidents which the gravity of the first case produces will also here be excited. It is only doing justice to the memory of M. Faure to state, that this second case was one which he also particularly intimated as demanding the immediate performance of amputation. See Prix de l'Acad. Royale de Chirurgie, tom. viii. p. 23. edit. 12mo.

Third case. If a similar body were to carry away a great mass of the soft parts, and the principal vessels of a limb (of the thigh for instance), without fracturing the bone, the patient would be in a state demanding immediate amputation; for, independently of the accidents which would originate from a considerable loss of substance, the limb must inevitably mortify. Mr. Guthrie also says, "a cannon-shot destroying the artery and vein on the inside (of the thigh), without injuring the bone, requires amputation." (P. 185.) When, however, the femoral artery or vein is injured by a musket-ball, or small cannister-shot, this gentleman recommends tying the vessel above and below the wound in it, if the nature of the case be evinced by hemorrhage. But he believes, that when both vein and artery are injured, amputation is necessary. (P. 186.) An injury of the femoral artery, observes Mr. Guthrie, requiring an operation, and accompanied with fracture of the bone of the most simple kind, is a proper case for immediate amputation.

tion; for although many patients would recover from either accident alone, none would surmount the two united, and the higher the accident is in the thigh, the more imperious is the necessity for amputation.

Fourth case. A large biscayen strikes the thick part of a member, breaks the bone, divides and tears the muscles, and destroys the large nerves, without, however, touching the main artery. According to M. Larrey, this is a fourth case requiring immediate amputation.

Mr. Guthrie also says, that "if a cannon-shot strike the back part of the thigh, and carry away the muscular part behind, and with it the great sciatic nerve, amputation is necessary, even if the bone be untouched, &c. In this case, I would not perform the operation by the circular incision, but would preserve a flap from the fore part or sides, as I could get it, to cover the bone which should be short." Guthrie on Gun-shot Wounds of the Extremities, p. 184.

Fifth case. If a spent cannon-shot, or one that has been reflected, should strike a member obliquely, without producing a solution of continuity in the skin, as often happens, the parts which resist its action, such as the bones, muscles, tendons, aponeuroses, and vessels, may be ruptured and lacerated. The extent of the internal disorder is to be examined; and if the bones should feel through the soft parts as if they were smashed, and if there should be reason to suspect from the swelling, and a sort of fluctuation, that the vessels are lacerated, amputation ought to be immediately practised. We learn from M. Larrey, that this is also the advice of M. Percy, an eminent French army surgeon. Sometimes, however, the vessels and bones have escaped injury, and the muscles are almost the only parts disordered. In this circumstance, we are enjoined to follow the council of M. La Martinière, who recommended making an incision through the skin. By this means, a quantity of thick blackish blood will be discharged, and the practitioner must await events. According to M. Larrey, such incision is equally necessary in the preceding case before amputation, in order to ascertain the extent of the mischief which the parts have sustained.

It is to such injury done to internal organs, that we must ascribe the death of many individuals, which was for a long while attributed to the commotion produced by the air put in motion by the ball, when this, in grazing upon different parts of the body, alters them, or cuts off the column of air which is to serve for respiration, just at the moment when it is about to enter the chest. See Ravaton's *Traité des Plaies d'Armes à Feu*.

But to return to the object of our present consideration. M. Larrey expresses his belief, that what have been erroneously termed *wind contusions*, if they are attended with the mischief above specified, require immediate amputation. The least delay makes the patient's preservation extremely doubtful. The internal injury of the member may be ascertained by the touch, by the loss of motion, by the little sensibility retained by the parts which have been struck, and, lastly, by practising an incision, as already recommended.

Sixth case. When the articular heads are much broken, especially those which form the joints of the foot or knee, and the ligaments, which strengthen these articulations, are broken and lacerated by the fire of a howitzer or by a biscayen, or other kind of ball, immediate amputation, says M. Larrey, is indispensable. According to this experienced writer, the same indication would occur, were the ball lodged in the thickness of the articular head of a bone, or were it so engaged in the joint as not to admit of being

extracted by simple and ordinary means. (See also Guthrie on Gun-shot Wounds, p. 197.) Putting out of consideration cases in which the injury has been done by a clean cutting instrument, or in which a small ball has passed near or partially injured a joint, another experienced army surgeon also lays it down as a law in military surgery, that *no lacerated joint, particularly the knee, ankle, or elbow, should ever leave the field unamputated, where the patient is not obviously sinking, and consequently where certain death would follow the operation.* (Hennen's Military Surgery, p. 42.) And in another place he tells us: "In my own practice, I have met with only two cases, where the limb was saved after a serious injury of the knee-joint; and in one of them only was the perfect use of it restored. I never met with an instance where the ankle or elbow-joint was perfectly restored after severe injury, though some where the limb has been saved. Of the shoulder-joint the recoveries are more frequent." P. 159.

Fractures extending into the joints, and accompanied with great laceration of the ligaments, were cases of gun-shot injuries pointed out by M. Faure as indispensably requiring immediate amputation. (See *Prix de l'Acad. de Chir.* tom. viii.) Thus we see, that this author was not so averse to early amputation as several modern writers have represented.

It is only in this manner, that the patients can be rescued from the dreadful pain, the spasmodic affections, the violent convulsions, the acute fever, the considerable tension, and the general inflammation of the limb, which, M. Larrey observes, are the invariable consequences of bad fractures of the large joints. But, adds this author, if the voice of experience be not listened to, and amputation be deferred, the parts become disorganized, and the patient's life is put into imminent peril.

It is evident, says he, that, in this case, if we wish to prevent the patient from dying of the consequent accidents, amputation should be performed before twelve or at most twenty-four hours have elapsed: even M. Faure himself professed this opinion, in regard to certain descriptions of injury. *Mém. de Chir. Militaire*, tom. ii.

With respect to wounds of the knee, the sentiments of Mr. Guthrie nearly coincide with those of M. Larrey. "I most solemnly protest (says Mr. G.) I do not remember a case do well, in which I knew the articulating end of the femur, or tibia, to be fractured by a ball that passed through the joint, although I have tried great numbers, even to the last battle of Toulouse. I know that persons wounded in this way have lived; for a recovery it cannot be called, where the limb is useless, bent backward, and a constant source of irritation and distress, after several months of acute suffering, to obtain even this partial security from impending death; but if one case of recovery should take place in fifty, is it any sort of equivalent for the sacrifice of the other forty-nine? Or is the preserving of a limb of this kind an equivalent for the loss of one man?" On Gun-shot Wounds, p. 196.

Mr. Guthrie admits, that fractures of the patella, without injury of the other bones, admit of delay, provided the bone is not much splintered.

Seventh case. According to M. Larrey, if a large biscayen, a small cannon-shot, or a piece of a bomb-shell, in passing through the substance of a member, should have extensively denuded the bone, without breaking it, amputation is equally indicated, although the soft parts may not appear to have particularly suffered. Indeed, the violent concussion produced by the accident has shaken and disorganized all the parts; the medullary substance is injured, the vessels

are lacerated, the nerves immoderately stretched, and thrown into a state of stupor; the muscles are deprived of their tone; and the circulation and sensibility in the limb are obstructed. Before deciding, however, M. Larrey cautions us to observe attentively the symptoms which characterize this kind of disorder. This case can be supposed to happen only in the leg, where the bone is very superficial, and merely covered at its anterior part with the skin.

The following are described as the symptoms: the limb is insensible, the foot cold as ice, the bone partly exposed, and on careful examination, it will be found that the integuments, and even the periosteum, are extensively detached from it. The commotion extends to a considerable distance; the functions of the body are disordered; and all the secretions experience a more or less palpable disturbance. The intellectual faculties are suspended, and the circulation is retarded. The pulse is small and concentrated, the countenance pale, and the eyes have a dull moist appearance. The patient feels such anxiety, that he cannot long remain in one posture, and requests that his leg may be quickly taken off, as it incommodes him severely, and he experiences very acute pain in the knee. When all these characteristic symptoms are conjoined, says M. Larrey, we should not hesitate to amputate immediately; for the leg would be attacked with sphacelus the same day, and the patient would certainly perish.

M. Larrey next adduces several interesting cases in support of the preceding observations.

Eighth case. When a large ginglymoid articulation, such as the elbow, or especially the knee, has been extensively opened with a cutting instrument, and blood is extravasated in the joint, M. Larrey deems immediate amputation necessary. In these cases, the synovial membranes, the ligaments, and aponeuroses, inflame, the part swells, and erethism rapidly takes place; and acute pains, abscesses, deep sinuses, caries, febrile symptoms, and death, are the speedy consequences. M. Larrey has seen numerous subjects die of such injuries, on account of the operation having been postponed with a hope of saving the limb. In his *Mémoires de Chirurgie Militaire*, tom. ii. some of these are detailed.

Although a wound may penetrate a joint, yet if it be small and unattended with extravasation of blood, M. Larrey informs us, it will generally heal, provided too much compression be not employed. This gentleman believes in the common doctrine of the pernicious effect of the air on the cavities of the body; yet, in this place, a doubt seems to affect him: speaking of the less danger of small wounds of joints, he says, "a quoi tient cette différence, puisque l'air pénètre dans l'articulation dans l'un comme dans l'autre cas?"

When two limbs have been at the same time so injured as to require amputation, we should not be afraid of amputating them both immediately, without any interval. We have, says M. Larrey, several times performed this double amputation with almost as much success as the amputation of a single member. He has recorded an excellent case in confirmation of this statement. *Mém. de Chirurgie Militaire*, tom. ii. p. 478.

When a limb is differently injured at the same time in two places, and one of the wounds requires amputation, (suppose a wound of the leg with a splintered fracture of the bone, and a second of the thigh, done with a ball, but without any fracture of the os femoris, or other bad accident,) M. Larrey recommends us, first to dress the simple wound of the thigh, and amputate the leg immediately afterwards, if the knee be free from injury. When it is necessary to

amputate above this joint, the less important wound need not be dressed till after the operation, provided it can be comprehended in the section of the member, or be so near the place of the incision as to alter the indication. When the wound demanding amputation is the upper one, the operation of course is to be done above it, without paying any regard to the injury situated lower down.

M. Larrey, however, approves of deferring the operation, when delirium, convulsions, and inflammation, prevail on the first receipt of the injury. In this circumstance, we are advised to take measures for appeasing these accidents; the progress of nature is to be carefully observed; and the first moment of quiet is to be taken advantage of for the performance of the operation. See Larrey's *Mém. de Chirurgie Militaire*, tom. ii. p. 451, &c.

Ninth case. To the foregoing species of gun-shot wounds, pointed out by M. Larrey as urgently requiring immediate amputation, are to be added compound fractures of the thigh from gun-shot violence.

"Gun-shot fractures of the thigh," says Dr. J. Thomson, "have been universally allowed to be attended with a high degree of danger; indeed, till of late years, very few instances have been recorded of recovery from these injuries. Ravaton acknowledges, that in his long and extensive experience, he had never seen an example of recovery from a gun-shot fracture of the thigh; and Bilguer, in his calculations with regard to those who recover from gun-shot fractures, sets aside those of the thigh-bone, as being of a nature altogether hopeless. In the present improved state of military surgery, instances not unfrequently occur of recovery from this fracture; but of these, the number will be found, I believe, to be exceedingly small, in comparison with those who die, particularly when the fracture has had its seat above the middle of the bone, &c."

According to the observation of Percy, scarcely two of ten recover of those who have suffered gun-shot fractures of the thigh-bone. Mr. Guthrie says, that "upon a review of the many cases which I have seen, I do not believe that more than one-sixth recovered so as to have useful limbs; two-thirds of the whole died either with or without amputation; and the limbs of the remaining sixth were not only nearly useless, but a cause of much uneasiness to them for the remainder of their lives." See Guthrie on Gun-shot Wounds, p. 191.

"In fractures by musket-bullets of the lower part of the thigh-bone (says Dr. Thomson), recovery not unfrequently takes place; and both Schmucker and Mr. Guthrie conceive, that they are injuries in which amputation may be delayed with safety. It would be very agreeable, that this opinion should be confirmed by future experience; but it appears to me, that before it can be received as a maxim in military surgery, much more extensive and accurate observation than we yet possess will be required, with regard to the proportion of those who recover without amputation, or after secondary operations, and of those who recover after primary amputation. Of those who had suffered this injury, we saw, comparatively, but a small number recovering in Belgium, and they had been attended with severe local and constitutional symptoms." See Report of Observations made in the Military Hospitals in Belgium, p. 247, *et seq.*

Balls often produce fissures of several inches in length in the thigh-bone. This is a state, observes Dr. Thomson, which must be very unfavourable to recovery; and his conclusion is, that in general, even in fractures of the lower part of the thigh-bone, a greater number of lives will be preserved in military practice by immediate amputation,

than by attempting the cure without that operation. "When the bone appears, on a careful examination, to be broken without being much splintered, and when the patient can be removed easily to a place of rest and safety, it may be right to attempt to preserve the limb; but if the bone be much splintered, or if the conveyance is to be long or uncertain, it will, in most instances, I am convinced, be a much safer practice, even in fractures of this part of the thigh-bone, to amputate without delay.

"Musket-bullets, in passing through the femur, near to the knee-joint, produce fissures of the condyles, which generally communicate with the joint. These cases, like those in which the bullets have passed directly through the joint, require immediate amputation.

"The writings of military surgeons contain but few histories of cases in which the thigh-bone had been fractured above its middle by the passage of musket-bullets. These are cases, I believe, which have generally had a fatal termination; and the danger attendant upon the amputation which they require, seems long to have deterred surgeons from attempting to ascertain what advantages might be derived from the employment of that operation. Schmucker recommends and states, that he had practised with success immediate amputation in those cases, in which a sufficient space was left below the groin for the application of the tourniquet. It is curious to remark, in the history of amputation, how long surgeons were in discovering the ease and safety with which the femoral artery may be compressed by the fingers, or pads, in its passage over the brim of the pelvis. Boy, from the immediate danger, protracted suffering, and ultimate want of success, which he had observed to follow this kind of injury, urges strenuously the propriety of immediate amputation: Mr. Guthrie's opinion, with regard to the dangerous nature of these injuries, and the advantages to be derived in them from immediate amputation, coincides in every respect with those of Schmucker and Boy. He observes, that those whose thigh-bone has been fractured in its upper part by a musket-bullet, generally die with great suffering before the end of the sixth or eighth week; and that few even of those escape, in whom that bone has been fractured in its middle part. Of the few whom we saw, who had survived gun-shot fractures in the upper part of the thigh-bone in Belgium, scarcely any one could be said to be in a favourable condition. In all, the limbs were much contracted, distorted, and swollen, and abscesses had formed round and in the neighbourhood of the fractured extremities of the bones. In some instances, these abscesses had extended down the thigh; but more frequently they passed upwards, and occupied the region of the hip-joint and buttocks. In several instances in which incisions had been made for the evacuation of matter, the fractured and exfoliating extremities of the bones sometimes comminuted, and sometimes forming the whole cylinder, could be felt bare, rough, and extensively separated from the soft parts which surrounded them. In other instances, these extremities were partially inclosed in depositions of new bone, which, from the quantity thrown out, seemed to be present in a morbid degree. It was obvious, that in all of these cases, several months would be required for the re-union of the fractured extremities; that in some much pain and misery were still to be endured from the processes of suppuration, ulceration, exfoliation, and ejection of dead bone; that in some cases, the patients were incurring great danger from hectic fever, and from diarrhoea; and that of those in whom this might take place, there was but little probability that any would be able to use their limbs!

The sight of these cases (says Dr. Thomson) made a deep impression upon my mind, and has tended to increase my conviction, that this is, of all others, the class of injuries in which immediate amputation is most indispensably required." See Report of Observations made in the Military Hospitals in Belgium, p. 254—258.

Dr. Thomson adds, that what has been said of the danger of fractures produced by musket-bullets in the upper part of the femur is true, in a still greater degree of those which have their seat in the neck or head of that bone. In such instances, Dr. Thomson joins the generality of modern army surgeons, in strongly recommending amputation at the hip-joint.

Of Gun-shot Wounds in which Amputation may be deferred.—If, says M. Larrey, it be possible to specify the cases in which amputation ought to be immediately performed, it is impossible to determine *a priori* those which will require the operation subsequently. One gun-shot wound, for example, will be cured by ordinary treatment, while another, that is at first less severe, will afterwards render amputation indispensable, whether this be owing to the patient's bad constitution, or the febrile complaints which are induced. However this may be, the safe rule for fulfilling the indication that presents itself, is to amputate consecutively only in circumstances in which every endeavour to save the limb is manifestly in vain. Upon this point, M. Larrey's doctrine differs from that of M. Faure.

The latter practitioner admits cases, which he terms *cases of the second kind*, in which he delays amputation, not with any hope of saving the limb, but in order to let the first symptoms subside. The operation done between the fifteenth and twentieth day, appears to him less dangerous than when performed immediately after the receipt of the injury. At the above period, according to M. Faure, the commotion occasioned by the gun-shot injury is dispelled; the patient can reconcile himself to amputation, the mere mention of which fills the pusillanimous with terror in a greater or lesser degree; the debility of the individual is no objection; and it is laid down as an axiom, "that the consequences of every amputation, done in the first instance, are in general extremely dangerous." In support of this theory, M. Faure adduces ten cases of gun-shot injuries, in which, after the battle of Fontenoy, the operation was delayed, in order that it might afterwards be performed with more success; a plan which, according to the author, proved completely successful. See *Prix de l'Acad. de Chirurgie*, tom. viii. edit. in 12mo.

This division of the cases for amputation into two classes, not consistent with nature, observes M. Larrey, has been the cause of a great deal of harm. Very often the partisans of M. Faure have not dared to resort in the first instance to amputation, the dangers of which they exaggerate; while, on other occasions, they amputate consecutively, without any success.

The effects of commotion, instead of increasing, gradually diminish and disappear after the operation. It is proved, says he, that the commotion, so far from being a counter-indication to immediate amputation, is a reason that should incline the surgeon to operate. Such was the sentiment of La Martinière and Boucher.

Neither ought the patient's alarm to be a reason for postponing the operation; for according to M. Larrey, the patient just after the accident will be much less afraid of the risk which he has to encounter, than after the expiration of the first four-and-twenty hours, when he has had time to reflect upon the consequences of the injury, or of amputation. This remark has been made by the illustrious Paré.

“Experience,” says M. Larrey, “has proved, both to the army and navy surgeons, that the bad symptoms which soon follow such gun-shot injuries as must occasion the loss of a limb, are much more to be dreaded than those of immediate amputation. Out of a vast number of the wounded, who suffered amputation in the course of the first four-and-twenty hours after the memorable naval battle of the first of June, 1794, a very few lost their lives.”

M. Larrey next acquaints us, that when he was sent to the army of Italy in 1796, he had also the pain of seeing in the hospitals great numbers of the wounded fall victims to the confidence which many of the surgeons of that army placed in the principles of M. Faure. General Bonaparte saw, that the *ambulance volante* was the only thing that, in the event of fresh hostilities, could prevent such accidents; and in consequence of his orders, M. Larrey formed the three divisions d’ambulance, which are described in his *Mémoires de Chirurgie Militaire*.

Since this period, it has always been customary in the French armies, on the day of battle, to make every preparation for performing amputation as speedily as possible. The mere sight of these *ambulances*, (always attached to the advanced guard,) says M. Larrey, encourages the soldiers, and inspires them with the greatest courage.

M. Larrey desires us to interrogate the invalids who have lost one or two of their limbs, and nearly all will tell us, that they suffered amputation a few minutes after the accident, or in the first four-and-twenty hours.

“If M. Faure now retains any partisans,” says M. Larrey, “I recommend them to repair to the field of battle the day after an action; they would then soon be convinced, that without the prompt performance of amputation, great numbers of soldiers must inevitably lose their lives. In Egypt, this truth was particularly manifested.”

Admitting, says M. Larrey, that by a concurrence of fortunate circumstances, which are not always to be calculated upon, some patients escape the danger of the first symptoms, this proves nothing in favour of doing the operation afterwards: it must be seen what nature will do towards the event of the case.

If at the end of twenty or thirty days the prognostic is as bad as it was previously, amputation cannot be avoided. Thus all the sufferings which the patient has endured have been undergone for nothing, and the operation will now be attended with considerable risk, inasmuch as the patient may lie in a dangerously weakened state.

If nature revives at all, no doubt the success of the operation becomes more probable; but in this case, the surgeon, instead of having recourse to amputation, should redouble his efforts to preserve the limb.

Cases demanding Amputation consecutively.—M. Larrey gives us the annexed information upon this subject.

First case. *A spreading Mortification.*—If the disorder be owing to an internal and general cause, it would then be rashness in the surgeon to amputate before nature had put limits to the disease. This kind of gangrene, according to M. Larrey, is distinguished from that which is named *traumatic*, by the symptoms which precede and accompany it. These symptoms are similar to those which are observed in nervous ataxia, or adynamia. Here the operation ought to be deferred, and endeavours made to combat the general causes with regimen and internal medicines.

But when the gangrene is *traumatic*, the limb, says M. Larrey, should be immediately cut off above the disorganized part. Several facts in support of this advice are related by this experienced surgeon in his *Mémoire sur la Gangrene Traumatique*. See SURGERY.

How contrary this advice to that inculcated by Sharp, Pott, and nearly all eminent surgeons of the present time!

A particular case of gangrene has been pointed out by Mr. Guthrie as demanding the early performance of amputation, and a deviation from the old rule of waiting till the mortification has ceased to spread. It is when gangrene occurs after wounds of the large blood-vessels of a limb. See Guthrie on Gun-shot Wounds of the Extremities, p. 63, &c.

Second case. *Convulsions of the wounded Limb.*—Amputation of the member, performed immediately the first symptoms of tetanus manifest themselves, more especially those of chronic tetanus, was proposed and even practised by Larrey with partial success. He supposed, that all communication between the original injury, and the rest of the body being thus cut off, the general disorder might cease.

Third case. *Bad State of the Discharge.*—It often happens, that in gun-shot wounds, complicated with fractures, notwithstanding the most skilful treatment, the discharge becomes of a bad quality; the fragments of bone lie surrounded with the matter, and have not the least tendency to unite; the patient is attacked with hectic fever, and a colliquative diarrhoea. Under these circumstances, life may sometimes be preserved by amputation.

Fourth case. *Bad State of the Stump.*—In hospitals, says M. Larrey, the cure of amputations is sometimes prevented by a fever of a bad character. The stump swells, the integuments become at first retracted, and then reverted and diseased a good way upward. The wound changes into a fungous ulcer, the cicatrization of which is hindered by the deep disorder of the bone, and the ulceration of the soft parts. The extremity of the bone projects. In order to remedy this last evil, it has been proposed to saw off the projecting part of the bone, and with this even to amputate all the flesh beyond the level of the skin. M. Larrey condemns such practice, as unnecessary and dangerous, and he recommends giving nature time to effect the exfoliation of the diseased projecting part of the bone, and heal the wound.

Of poisoned Wounds.—These injuries are essentially different from every other description of wound, their great particularity depending upon the introduction of a venomous matter into the wounded parts, or its deposition upon the surface of the injury; and, in general, the poison is inserted by the weapon with which the solution of continuity is produced. Sometimes, however, the contrary happens, when previous cuts, or scratches of the fingers, which are not healed, become infected with a virus, in the dissection of bodies, or in the dressing of venereal ulcers. Nay, there has lately been recorded in the public papers a remarkable instance, in which a nobleman’s servant died, as is alleged, from the effects of the poison of a torpid viper, the fangs and poisoned apparatus of which he had been handling and exhibiting to some visitors, at a time when he happened to have a slight cut upon one of his fingers. The case is extraordinary, not only on account of the way in which the infection was contracted, but also on account of the fatal event, which is very uncommon in animals of the magnitude of the human subject, as we shall hereafter notice.

Pricks with the point of a dissecting-knife, when the instrument is covered with putrid, infectious, irritating matter, may be considered as a class of poisoned wounds. Sometimes, however, such accidents are followed by no injurious effects; and when the subject is strong and robust, a little inflamed tumour occurs in the situation of the puncture, the part festers, bursts, and then heals up. But, as Richerand observes,

observes, when the accident befalls a young man, who has been much weakened by hard study, any kind of excess, or some previous disease, it frequently happens that no local symptoms are seen. At the end of 24 or 36 hours, sometimes rather sooner, sometimes later, the axillary glands become affected with swelling, and a painful phlegmonous inflammation takes place in them. The wound afterwards festers; the parts around it exhibit appearances of a slow sort of inflammation, and the consequent swelling of the hand is rather œdematous than inflammatory. Next often succeed nausea and propensity to vomit, prostration of strength, a small accelerated pulse, and all the usual symptoms of typhus fever. Under these circumstances, if, instead of a tonic plan of treatment, which is strongly indicated, the evacuating method be adopted, the patient very soon falls a victim.

Experience fully proves, that in strong vigorous habits, nature resists with energy the introduction of poisons into the system.

In the cases under our consideration, tonic and cordial remedies are to be given in moderation. At the same time, care is to be taken to clear out the *primæ viæ*, when they appear to be disordered. Abroad, it is the common practice also to apply a grain of caustic potassa, or a drop of the liquid muriate of ammonia, to the little wound itself.

The stings of venomous insects, such as the bee, wasp, hornet, &c. are commonly treated of with poisoned wounds. The pain of the injury is alleged to depend less upon the introduction of the sting, which sometimes breaks and is left behind, than upon the insertion of a venomous fluid into the part. It is said indeed, that the experiments made by professor Dumeril prove, that when the little cyst, situated at the base of the sting, is removed, the introduction of the sting itself into the flesh causes no particular pain. At the base of the sting there is a kind of vesicle, or reservoir, for containing the poisonous secretion, which is expelled and flows out along the sting, at the instant when the latter penetrates the parts which are stung. The venom of the bee is stated to be neither of an acid nor of an alkaline nature. When applied to mucous surfaces, and even to the tunica conjunctiva of the eye, it produces no disagreeable sensation; but if the point of a needle, after being dipped in it, be introduced into the flesh, a very acute pain is immediately excited. Various kinds of oil, honey, ammonia, spirit of wine, and several other reputed specifics, appear to deserve no such character, since they are found, after unprejudiced trials, to have no power of neutralizing the venom, nor of appeasing the actual pain arising from the sting.

When, therefore, a person has been stung by one or several bees, we are recommended to begin with extracting the stings, taking care, however, previously to cut off with a pair of scissors the little vesicle at their base containing the venomous secretion. This is to be done, lest in the endeavours to remove the sting more of the venom should be compressed out of the little reservoir into the wound. The part is afterwards to be covered with snow, or bathed with ice-cold water, or some cooling sedative lotion. In short, the case is to be treated on common antiphlogistic principles, experience having fully proved that no specific has yet been discovered for the sting of the bee, and other venomous insects. For other opinions and observations on this subject, see the article BEE.

Bite of the Viper.—Of all the venomous reptiles which are met with in Europe, there are none which inflict so dangerous a bite as the viper or adder. Its upper jaw is furnished with two moveable fangs, which are very sharp-

pointed, grooved longitudinally, and at their root are connected with a vesicle which contains the venomous fluid. When the animal is irritated, the fangs become raised, and the poison flows along the grooves in them into the bitten part. The danger of the injury is in some measure proportioned to the fury of the animal; for when it is very much exasperated, it closes its jaws with greater force, and more of the venom is compressed into the wound. The degree of danger is also influenced considerably by the greater or less space of time that has elapsed since the reptile emptied the receptacles of its venom, by biting another person or animal. The injury likewise is generally found to produce less serious consequences, in proportion to the greater size of the animal which has been bitten. The experiments of Fontana prove, that the bite of a single viper will kill a mouse, a pigeon, or any other small animal; but that it must be the bites of several to kill a man, and of a still larger number to destroy an ox. It is also supposed by many writers on this subject, that in all animals, whatever may be their size, the degree of danger is considerably greater, if they should be much frightened on the occasion, the prostration of strength produced by fear being conjectured to facilitate in a peculiar manner the pernicious operation of the venom. When a dog is bitten suddenly and unexpectedly, he is, *cæteris paribus*, much less hurt than when he has received the injury in a contest with the reptile, whose very aspect has more or less alarmed him. The bite of the viper is thought to prove generally more or less severe, in proportion to the heat of the weather.

The danger of the injury depends less upon the laceration of the parts, which, however, is considerable, than upon the kind of venomous inoculation with which it is attended. The symptoms which are excited come on almost immediately. The person who has received the bite suffers acute pain, and an inflammatory swelling spreads up the limb with remarkable rapidity, accompanied with a tendency to gangrene, as is indicated by the appearance of livid spots. Affections of the heart, attended with great weakness and vertigo, denote that the action of the poison extends to the whole system. But these general effects do not arise, as Fontana wrongly imagined, from the venom having a power of coagulating the blood in the vessels, but in all probability from its operation upon the nervous system.

The best plan of counteracting the baneful effects of the bite of the viper consists in introducing a few drops of the fluid muriate of antimony into the wound, and a small hair pencil may be used for the insertion of the caustic, if the punctures should happen to be deep. Indeed, when the bottom of the wound cannot be cauterized without dilating it, the latter step is deemed proper by the generality of surgical writers. The surrounding parts may be rubbed with a liniment composed of hartshorn and olive-oil; and cordial medicines are to be exhibited, especially ammonia.

The amputation of the bitten part is rather too severe a mode of preventing the usual ill consequences of the bite of a viper to deserve recommendation. The ancients, with a view of counteracting the introduction of the poison into the body, were accustomed to apply a ligature round the limb above the injury; but it is a painful expedient, because it cannot hinder the absorption of the venom, and the general constitutional affection, unless the band be put on with sufficient tightness to impede the circulation. This, however, is the method which was adopted by Ambroise Paré, after he had been accidentally bitten by an adder.

The most important object in the treatment is the prompt application of remedies; for the introduction of the virus into

into the constitution ought to be prevented, if possible. This is more likely to be accomplished than any aim at neutralizing the venomous fluid, after its effects have extended to the whole animal economy.

Even when the bite of a viper is entirely neglected, it very rarely proves fatal to the human subject. In many cases, the patients have recovered favourably under the mere use of olive-oil and of ammonia. These two medicines have been recommended as specifics both in the Transactions of the Royal Society, and by the celebrated Bernard de Jussieu; and amongst the cases in proof of their efficacy, authors still continue to quote the example of a dealer in vipers, who was quite indifferent about being bitten by these animals. He used to bathe the part in olive-oil, and at the same time drink several ounces of this fluid. And in another instance, which is frequently cited, a student of botany, while herborizing, was bitten by a viper in a place where no medicine was at hand, except the eau de luce. Jussieu, who was present, introduced a few drops of this remedy into the wound, and administered a tea-spoonful of it internally in a glass of water. The eau de luce is nothing more than the liquor ammoniæ, containing a small quantity of the oleum succini.

In France, and in other parts of the continent, the eau de luce is still looked upon as the internal medicine, on which most reliance can be placed.

In this country, arsenic, in strong doses, has been particularly recommended for its beneficial effects in counteracting the operation of the poison of snakes. The Tanjore pill, which has long been famous in India for its virtues in preventing the fatal symptoms arising from the bites of serpents in hot countries, was known to have arsenic as one of its ingredients. Mr. Ireland, an army surgeon, happened to be at St. Lucia, in the West Indies, when several men of the 62d regiment were bitten by the coluber carinatus of Linnæus, the bite of which had already proved quickly fatal to several men of the same corps. Mr. Ireland immediately administered Fowler's solution of arsenic in strong doses, and the results of the cases, in which he had an opportunity of trying it, were highly favourable to the practice, as the men's lives were preserved by it. (See *Medico-Chir. Trans.* vol. ii. p. 393, &c.) Perhaps the prompt excision of the bitten part, or the free use of the actual cautery, should also be invariably put in practice, for the bites of the more deadly kinds of serpents, in conjunction with the exhibition of arsenic. But the ordinary consequences of the bite of a common adder are not serious enough to require so severe a proceeding as the excision or amputation of the parts would often be. Some observations on the structure of the viper will be found in the article COLUBER, and other remarks on the bite of this animal will be seen in the articles POISON and VIPER.

The worst poisoned wounds ever met with in this climate are those produced by the bite of a mad dog, and other rabid animals; but for a particular account of this highly interesting subject, we must refer to HYDROPHOBIA.

Wounds of different Parts of the Face, Eye, Eye-lids, Ears, &c.—The countenance being the part in which any deformity is peculiarly conspicuous, it is always a great desideratum, in cases of wounds of the forehead, cheeks, nose, lips, &c. to prevent as much as possible the formation of ugly scars. Hence it is an invariable maxim to endeavour to heal wounds of the face by the first intention.

As cuts of the face can hardly be very deep, adhesive plaster is generally sufficient for holding their opposite edges together; but when the wound is situated in the lips, these

parts are so incessantly in motion, that surgeons find it best to maintain the sides of the division in contact by means of the twisted suture, a description of which is given in the article HARELIP.

When the edges of a wound of the lips are much contused and lacerated, some authors recommend them to be pared off, in order to increase the chance of union, and lessen the disfigurement of an uneven cicatrix.

Punctures of the transparent cornea of the eye are in themselves much less serious accidents than similar injuries of the sclerotic coat, which are almost unavoidably combined with a wound of the choroides and retina. Hence, the latter cases are frequently followed by a considerable degree of inflammation. Sometimes the crystalline lens itself is injured, and afterwards grows opaque.

Incisions made in the transparent cornea with very sharp instruments may not give rise to any serious consequences; and notwithstanding the escape of the aqueous humour, the crystalline lens and vitreous humour may remain in their natural situation. The form, thickness, and density of the cornea are circumstances which produce a spontaneous approximation of the edges of the wound to each other, and which, in fact, are extensively in contact. But the coaptation is rendered very exact, and a quick re-union much promoted, by drawing down the upper eye-lid, so as to shut the eye; in which state, the cartilaginous tarsus of the upper eye-lid makes an uniform compression on the cornea, in a manner which is extremely useful. Cuts of the sclerotica are not in general so simple. The choroides and retina may be at the same time either divided or exposed. In the first case, the expulsion of the whole of the vitreous humour, and a total disorganization of the eye, are to be apprehended from the immediate spasmodic contraction of the muscles of this organ; and, in the second, a violent and dangerous ophthalmia is to be expected. When, in the instance of a large wound of the sclerotica, choroides, and retina, the contents of the eye-ball are discharged, the organ inflames, and gradually shrinks into a much smaller mass, which is moveable, and capable of supporting an artificial eye.

Contused wounds of the eye-ball are mostly followed by a destruction of the functions of the organ, either in consequence of the concussion of the retina, or of the inflammation to which these injuries usually give rise. However, in a few cases, even contused wounds of the eye have united very favourably, and without the loss of vision. Sometimes the solution of continuity extends through the sclerotica, while the conjunctiva itself is not ruptured. Delpsch affirms, that he has seen several such cases, in which the latter membrane presented the appearance of an ecchymosis opposite the division of the sclerotica, and confined the humours of the eye, which otherwise would have been lost. *Précis des Maladies Chir.* tom. i. p. 349.

Nothing is more likely than gun-shot wounds to produce a violent concussion of the retina, and an incurable paralysis of this nervous expansion. The smallest particle of lead, which either strikes or penetrates the eye-ball, may occasion those effects. Every other severe contusion of the eye may act in the same way. When the extravasation of blood originating from an accident of this kind is not attended with a serious concussion of the retina, the effused blood will be absorbed, and the functions of the eye restored.

In all cases of wounds of the eye, says M. Delpsch, there are three fundamental indications; first, to prevent the expulsion of the vitreous humour and crystalline lens; secondly, to promote the quick re-union of the wound by placing its edges very accurately together; and thirdly, to do

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do every thing in our power to avert inflammation. The two first objects cannot be fulfilled without keeping the eye-lids continually closed. The prompt re-union of the wound is one of the most effectual means of preventing inflammation; but when this affection cannot be entirely hindered, it is to be resisted by the kind of treatment which is explained in the article OPTHALMY.

Wounds made with pointed instruments may pass through the eye-lids into the orbit, and thence through the thin bones which compose this cavity into the brain; or the weapon may penetrate directly between the eye-ball and side of the orbit into the brain. Injuries of this description generally prove fatal on the spot, though sometimes the patient lingers for a few hours.

In many instances, an injury by a ball, inflicted in the neighbourhood of one eye, produces paralysis of the other. Pierre Roussillier, of the 25th regiment of the line, in the service of Napoleon, (says Mr. Hennen,) was wounded on the 18th of June, at Waterloo. The ball entered the right eye; the left, though not in the slightest degree injured to appearance, was completely blind. Rare, however, are the cases where death does not follow all wounds, particularly small punctured ones, going directly forward into the orbit, as this did. I felt under the zygoma, and all along the neighbourhood of this poor fellow's wound; but in the puffy state of the parts could not detect the course of the ball. He himself was confident it had gone into his brain. He returned to France convalescent. Garengot (*Traité des Operations*, vol. iii. obs. 20.) gives us an interesting case from the lectures of Petit, in which a soldier received a wound towards the great angle of the eye. It was deemed but of little consequence, and healed under the common hospital treatment. The man expressed a wish to leave the hospital, although cautioned by the surgeon, and had scarcely reached the door when he was seized with rigors, obliged to return, and died in two days. On dissection, the ball was found lodged under the sphenoid cells and the hole of the optic nerve. The effect on this man's sight is not mentioned." Hennen's *Obs. on Military Surgery*, p. 360.

Wounds of the lower part of the forehead, or eye-brow, are sometimes followed by the disorder named *ptosis*, in which the upper eye-lid hangs down more or less over the eye; but more commonly they give rise to an opposite complaint, called *lagophthalmus*, in which, from a contraction of the cicatrix, the skin is drawn up, and the upper eye-lid cannot be made to cover the eye. See those terms.

Wounds of the eye-brows sometimes cause a species of blindness named the *gutta serena*. This consequence is commonly thought to be owing to an injury of the nervous filament, which comes out of the orbit at the notch in the superciliary ridge. It is very probable, however, that the affection of the eye is not altogether dependent on the injury of the nerve; for the blindness very often occurs when the cut is not situated near the track of the nerve, and frequently does not occur when the nerve is known to be wounded. According to Richter, it is when the wound is nearly or quite healed that the event is most likely to happen.

Scarpa has set down the *gutta serena*, arising from an injury of the supra-orbital nerve, as absolutely incurable; but we know that this statement is not altogether correct; for Mr. Hey has recorded in the *Med. Obs. and Inquiries*, vol. v. an example of amaurosis which got well, though it originated from a wound of the eye-brow. See *GUTTA Serena*.

Mr. Hennen says, he has met with one or two cases of amaurosis from wounds of the supra-orbital nerve. The per-

fect division of the nerve did no good; but after some time the eye partially recovered. On *Military Surgery*, p. 366.

Wounds of the eye-lids scarcely admit of an effectual application of adhesive plaster, and their edges are generally brought together with a suture. There are some practitioners, however, and amongst them is M. Delpech, who consider the use of sutures, even in these cases, quite unnecessary. *Précis des Maladies Chir.* tom. i. p. 346.

Sabre-strokes, directed obliquely downward against the face, very often produce a wound with a flap, which should be immediately laid down in its proper situation again. When the flap is large and muscular, Richter thinks it best to use a suture at one or two points, as the strips of adhesive plaster are apt to become displaced, especially if the patient is restless, and then the flap of skin, not being sufficiently retained, slips downwards, and the part is not healed without deformity. However, it certainly has always appeared to us that a suture in this instance may be dispensed with, if care be taken to assist the effect of the adhesive plaster with a compress and bandage. *First Lines of the Practice of Surgery*, p. 291. edit. 3.

Sabre-wounds sometimes break and splinter the bones of the face. The fracture, however, seldom extends far, because most of these bones are soft and spongy. Notwithstanding such injury of the bones, the wound of the soft parts frequently admits of being united, if care be taken to extract all the splinters, and put the surfaces of the division of the bones as evenly together as possible. Unless the fragments are quite detached they should never be taken away, but be replaced as well as circumstances will permit. Their removal is not an easy matter, it occasions an unpleasant disfigurement, and experience proves that all divisions of the bones of the face heal with particular readiness. (*Anfanggr. der Wundarzneeykunst*, b. ii. p. 244. edit. 3.) A very terrible sabre-wound of the face is recorded by Mr. Hennen. The weapon struck an officer nearly across the eyes, one of which it destroyed; it then divided the parts downwards and inwards to such an extent, that the pharynx could be seen. Yet the injury healed in a very favourable manner, as indeed do all wounds of the face, owing to its great vascularity. See *Obs. on Military Surgery*, p. 370.

In some horrid cases, where the lower jaw is swept away by a cannon-shot, life is preserved; but, in general, the patient sinks under the accumulated tortures of his situation. "It is still, however, our duty," as Mr. Hennen observes, "to try every expedient; and after the ragged parts and splinters of bone are removed, the vessels within reach secured, and the suppurating process fairly established, we may endeavour to assist nature, faithfully following any effort she may make to fill up the chasm, but without allowing ourselves to count upon a showy or complete cure." (*Op. cit.* p. 373.) This gentleman saw a horrid-looking case, in which nearly one half of the face was carried away by a round shot at Waterloo, in a very fair progress of contraction. Larrey has likewise recorded a similar cure; and the writer of this article once witnessed in Holland a most extraordinary recovery of the same nature. It was the case of a soldier, wounded at the assault of Bergen-op-Zoom, in 1814, who was afterwards brought into one of the military hospitals of Oudenbosch. All the lower jaw, and a large part of the upper, were in this instance completely torn away. There was very little hemorrhage, and no vessels required the ligature.

For some observations on wounds of the tongue, we beg to refer to the article *TONGUE*.

When a part of the nose is divided, but not entirely detached, it is the duty of the surgeon to replace it as expeditiously as possible. When adhesive plaster does not appear to

be capable of securing the part in its proper situation, a future may be employed. Writers usually advise keeping the nostrils pervious with soft flexible tubes, chiefly with a view of giving vent to the mucus which is secreted by the inflamed Schneiderian membrane, and which, if it could not readily escape, might prove exceedingly annoying to the patient. Putting out of the question Garengot's extraordinary case, and a few others to which we have already adverted in a previous part of this article, we have many facts on record, proving not only that most incised wounds of the nose admit of union, but also that contused ones, attended with an almost complete detachment of the part, may often be united. In one instance, the cartilaginous portion of a young man's nose was nearly bit off by a horse, the separated piece only hanging by a thin portion of skin; yet after being replaced, and three stitches made, the part was united without any material deformity. Richter's Chir. Bibliothek, 6 band, Seite 538, and Cooper's First Lines of Surgery, p. 282. edit. 3.

As the parotid duct passes beneath the integuments of the cheek over the masseter muscle, it is much exposed to wounds, which, if not properly treated, end in what are termed salivary fistulæ. Having considered this subject in a separate article, (see *Salivary FISTULA*,) we shall not dwell upon it at present. A late writer informs us, that in injuries of the parotid duct he has sometimes derived advantage from making the division complete by a clean incision across the duct into the mouth, and closely bringing together the edges of the wound on the outside of the cheek. The natural flow of saliva into the mouth kept the wound from healing up on the inside of the cheek. Hennen's Military Surgery, p. 374.

With respect to wounds of the external ear, experience has fully proved that they are cases which usually terminate favourably. Incised wounds and fibre-cuts of the ear mostly heal extremely well. Ravaton has recorded a case in which the ear united again, although it had been nearly separated from the head; and another instance of such success is mentioned in Cooper's Dict. of Surgery, art. *Wounds*. These and many other facts which might be quoted leave no doubt of the propriety of always making an attempt to unite parts, whenever the least connection between them remains.

Surgical authors differ in their statements about the effects of the total loss of the external ear upon the power of hearing. Thus it is asserted by M. Richerand, that the external ear, which is a sort of instrument calculated for concentrating the rays of sound, may be totally cut off without deafness being the consequence. For a few days after the loss, he says, the hearing is rather hard; but the infirmity gradually diminishes, the increased sensibility of the auditory nerve compensates for the imperfection of the organic apparatus, and the acuteness of the sense is entirely restored. (Richerand, *Nosographie Chirurgicale*, tom. ii. p. 122. edit. 2.) However, if we are to credit the statement of other writers, the recovery is far less complete than M. Richerand represents it to be. Thus Leschevin notices, that they who have lost the external ear, or have it naturally too flat, or ill-shaped, have the hearing less subtle. The defect can only be remedied by an artificial ear, or an ear-trumpet, which receiving a large quantity of the sonorous rays, and directing them towards the meatus auditorius, thus does the office of the external part of the ear. *Prix de l'Acad. Royale de Chirurgie*, tom. ix. p. 120. edit. 12mo.

Wounds of the external ear, whatever may be their size and shape, do not require a different treatment from that of the generality of other wounds. The re-union of the divided part is the only indication, and it may be in most instances easily

fulfilled by means of methodical dressings. Such writers as have recommended futures for wounds of the ear, (says Leschevin,) have founded this advice upon the difficulty of applying to the part a bandage that will keep the edges of the wound exactly together. The cranium, however, affords a firm and equal surface, against which the external ear may be conveniently fixed. Certainly, it is not more easy to secure dressings on the nose than the ear; and yet cases are recorded in which the cartilaginous part of the nose was wounded, and almost entirely separated, and the union was effected without the aid of futures. See *Mem. de M. Pibrac sur l'Abus des Sutures*, in *Mem. de l'Acad. de Chir.* tom. iii.

In wounds of the ear, then, we may conclude that futures are generally useless and unnecessary. As examples may occur, however, in which the wound may be so irregular and considerable as not to admit of being accurately united, except by this means, it should not be absolutely rejected. An enlightened surgeon will not abandon altogether any curative plans; he only points out their proper utility, and keeps them within the right limits. When sticking-plaster, simple dressings, and a bandage, that makes moderate pressure, appear insufficient for keeping the edges of a wound of the ear in due contact, the judicious practitioner will not hesitate to employ futures.

When a bandage is applied to the external ear, it should only be put on with moderate tightness, since much pressure gives considerable uneasiness, and may induce sloughing of the part. In order to prevent these disagreeable effects, M. Leschevin advises us to fill the space behind the ear with soft wool or cotton, against which the part may be compressed without risk. *Op. cit.* p. 119.

In the application of futures, the ancients have cautioned us to avoid carefully the cartilage, and to sew separately, one after the other, the skin of both sides of the ear. They were fearful, that pricking the cartilage would make it mortify, "ce qui est souvent-fois arrivé," says Paré. But notwithstanding so respectable an authority, the moderns make no scruple about sewing cartilages. In wounds of the nose, Verduc expressly directs the skin and cartilage to be pierced at once in applying futures, and the success of the plan is put out of all doubt by a multitude of facts. The same treatment may also be safely extended to the ear. See Leschevin's *Obs.* in *Op. cit.*, and Cooper's *Dict. of Pract. Surgery*, art. *Ear*.

Wounds of the Throat.—As Mr. John Bell has observed, there are several anatomical points which should be well remembered by the surgeon in all cases of wounds about the throat. First, it is to be recollected, that the arch of the aorta lies in the upper part of the chest in front of the trachea; and that where the carotid arteries come out of the chest to go up along the neck, they are scarcely at the sides of the trachea; they rather run before it. But, that as the arteries mount up the neck, they incline more to the side of the trachea; and that at the upper part of the neck, they are entirely behind that tube; for they incline towards the angle of the lower jaw, and having reached it, they begin there to give off their branches both to the head and neck. Hence we see the reason why a wound at the lower part of the neck is very often fatal, while a wound higher up is generally less dangerous. The suicide seldom strikes at the lower part of the neck; and it is from the accidental circumstance of his cutting very high up, near the chin, that the carotids escape.

Secondly, as the same author has explained, it should be remembered, that the carotid artery, the great jugular vein, and the par vagum, or eighth pair of nerves, lie very closely

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connected with each other, being all inclosed in one mass of cellular substance, which forms something like a sheath for them. Now, says Mr. John Bell, since this eighth pair is one of the greatest nerves of the viscera, and since, by experiments upon animals, we know well that a wound of it is more fatal than a wound of the brain itself, this puts an end at once to all questions about the way of managing wounds of the carotid artery, or of the great vein. No doubt these may sometimes be partially wounded and the nerve escape; but, in general, the nerve will be cut along with them; and, at all events, the fatal consequences which would arise from including this nerve in a ligature, make it absolutely necessary that whenever the carotid is tied, it be first carefully separated from every other part. See John Bell's Discourses on Wounds, p. 415. edit. 3.

That the internal jugular vein, or the carotid artery itself, may sometimes be partially injured, without a wound of the par vagum, or the patient instantly perishing, has now been fully proved. The writer of this article knew of a case, which happened in the campaign in Holland in 1814, where the internal jugular vein was ruptured by the passage of a musket-ball down the neck; and yet the patient lived more than an hour after the accident, and when he died it was from suffocation, in consequence of the pressure of a large mass of extravasated blood upon the trachea. M. Larrey has related a very singular case: an officer received a gun-shot wound, which cut the external carotid at its separation from the internal, and in its passage through the parotid gland. Pressure made by an intelligent soldier at the moment, and subsequent bandages, saved the patient. (See Mémoires de Chir. Militaire.) This case is singular, because it is very uncommon for hemorrhage from so large a vessel as the external carotid to be permanently stopped by simple pressure, nor should we recommend the method to be imitated; for there is not in all surgery a better rule than that of trusting only to the ligature in every wound of a great artery. Mr. Hennen, however, informs us, that he knew of an English officer, who was also saved in India from the effects of an arrow wound in the carotid by the same means. (Obs. on Military Surgery, p. 180.) Such a mode of treatment we believe would fail a thousand times in succession; and the alleged cures would be more valuable, if it were always quite impossible to mistake hemorrhage from a branch for a bleeding from the trunk itself.

The writer of this article is acquainted with an army surgeon, in whose veracity he perfectly confides, who states, that he was once called to a soldier who had wounded the trunk of the carotid with a bayonet. The vessel was instantly taken up, and the man's life saved. In a modern publication may also be found another example, in which the carotid burst, and was taken up on the spot by Mr. Fleming, a naval surgeon. See Medico-Chir. Journal, vol. iii. p. 2.

Without positively maintaining, as Mr. J. Bell does, that it is impossible to cut through the trachea so as to open the œsophagus, without wounding the carotid artery, the jugular vein, and the eighth pair of nerves, we join him in believing that such an accident must be exceedingly rare. How then are we to explain the many alleged cures which are said to have been effected, notwithstanding the windpipe and œsophagus are stated to have been both cut through? We are to account for these extraordinary narratives in the manner so well pointed out by Mr. John Bell. "The fact is (says he), that neither the œsophagus nor the trachea is touched in the least degree, but the wound is much above them; for a suicide always strikes immediately under the chin. This wound, as far as I have observed, commonly

falls in the line which divides the neck from the chin; that is, the place where the os hyoides lies, and he commonly cuts the os hyoides away from its connection with the thyroid cartilage, or pomum Adami. In that case, the thyroid cartilage, forming the uppermost part of the larynx, is not touched; the rima glottidis lies below the wound quite safe. The wound indeed separates the epiglottis from the glottis; but it leaves the glottis and the larynx quite safe. It only separates the larynx from the root of the tongue; it is properly a wound in the root of the tongue; it is rather a wound of the mouth than of the throat; and when the food comes out, along with spittle and froth, it is by rolling over the root of the tongue." On Wounds, p. 417.

That, however, the trachea and œsophagus may be both cut in a few cases, without immediate death from hemorrhage, we decidedly believe, because there are too many facts on record to admit of any doubt on the subject. See Default's Journal and Saviard, obs. 58. Hennen's Military Surgery, p. 386.

In these high wounds of the throat, it is the superior thyroid artery which is most frequently cut. This vessel, after quitting the external carotid at the angle of the jaw, passes along the side of the upper part of the trachea, inclining forward towards the thyroid gland in its descent, and being therefore much exposed to the edge of the razor. The bleeding from this artery is profuse, and if not speedily stopped is as fatal as hemorrhage from the carotid itself. In some of these cases, the bleeding also proceeds from branches of the lingual artery.

Wounds of the carotid artery, or jugular vein, commonly prove immediately fatal from loss of blood, before any assistance can be obtained. If a surgeon, however, were to arrive in time to render aid, it would be his duty immediately to apply a ligature both below and above the wound of the vessel. This is the only plan which affords any chance of saving the patient's life, and, as we have already noticed, it has actually been done with success in a few uncommon instances, in which the surgeon was not too late. In passing the ligatures beneath either of those vessels great caution is requisite; for the eighth pair of nerves lies close to it, included in the same sheath of cellular substance, and the inclusion of so important a nerve in the ligature would have fatal consequences. Its situation on the outside of the artery, between it and the jugular vein, should therefore be always carefully remembered. According to Richter, the internal jugular vein has actually been tied with success. Small wounds of the same vessel, if we are to credit the accounts of this author, may sometimes be healed by means of a graduated compress, which must be retained on the part with a bandage, or, if that prove irksome, with the finger. One thing, however, is essential; namely, the pressure must on no account be remitted, until the wound in the vessel is closed. Richter's Anfanggr. der Wundarzn. b. iv. p. 173., and Cooper's First Lines of Surgery, p. 386. edit. 3.

M. Pelletan once saw a wound of the throat, which proved fatal in consequence of hemorrhage from the external jugular veins; and the same eminent surgeon met with another curious instance, in which a boy, who was convalescent after a cut of his throat, suddenly fell down in a state of suffocation and died: on examining the parts after death, it was discovered, that the left side of the epiglottis had been detached from the glottis and root of the tongue, and that in this loose unconnected state it had fallen upon the rima glottidis, and closed it so completely as to cause instantaneous suffocation. See Leveillé's Nouvelle Doctrine Chir. tom. i. p. 342, 343.

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Wounds of the trachea are either simple or complicated. In both descriptions of cases, the usual symptoms are, an emission of air between the lips of the wound, loss of the voice, and sometimes emphysema. Such injuries of the windpipe as are not complicated either with hemorrhage, emphysema, or loss of substance, may for the most part be easily cured by means analogous to those which are employed for the cure of wounds in general. The re-union is still more easily accomplished, when the trachea is divided longitudinally, than when it is cut transversely. If the wound be of a certain size, and attended with hemorrhage, the first indication is to tie the bleeding vessels, and, in particular, to obviate the inconvenience and danger which would result from the insinuation of the effused blood into the windpipe; an occurrence which has sometimes proved fatal. (Wilmer's Cases and Remarks in Surgery, p. 92.) In order to prevent such an unfavourable event, some surgical writers recommend the external wound not to be closed while any oozing of blood continues, so that this fluid may readily find an external outlet, instead of falling into the trachea. (Lassus, Pathologie Chir. tom. ii. p. 291.) To us it appears, that the best mode of preventing the occurrence is to bring the edges of the wound of the trachea into contact by a suitable position of the patient's head, and, if requisite, even by a suture.

The greater sensibility of the larynx, its complicated structure, and the number and size of its blood-vessels, *ceteris paribus*, render wounds of it much more dangerous than those of the trachea. In the first volume of the Mémoires de l'Acad. de Chirurgie in 4to. many cases may be consulted which furnish proofs of this observation. In general, however, wounds of the thyroid cartilage heal very favourably, when not accompanied with injury of other important parts.

Transverse wounds, dividing only the anterior half of the upper part of the trachea, usually have a favourable termination, and when the cases are of this description, the carotids and jugular veins for the most part escape injury. Gun-shot wounds of the trachea are more dangerous, but experience proves that they also frequently end well.

The greater number of transverse wounds of the trachea, which have not divided this tube completely through, readily admit of cure by the strict observance of a proper position. When the patient's chin is brought downward and forward towards the sternum, and the head is maintained in this posture with pillows, the edges of the wound in the trachea become spontaneously approximated to each other, and in time will grow together.

The manner in which the employment of sutures aggravates the cough, and inflames the wound, often necessitates the surgeon to withdraw them when they have been applied. It may also be truly asserted, that besides the irritation which they create in the trachea as extraneous substances, they are (to say the best of them) very unnecessary. Nothing has a greater tendency to impede the union of a wound of the trachea than the disturbance of a frequent convulsive cough; and the irritation of sutures always increases this hurtful symptom in a much greater degree than they can do good by maintaining the edges of the wound in contact. In fact, unless the greater portion of the diameter of the trachea be divided, there never can be such a space between the edges of the wound, that they cannot be brought together with the assistance of a judicious posture of the head.

When the patient is much afflicted with incessant coughing, and the inflamed state of the wounded parts appears to operate as the cause of this disagreeable symptom, relief is

to be obtained from bleeding, and the exhibition of soothing and aperient medicines. In cases in which no particular local irritation can be suspected of giving rise to the cough, the surgeon may prescribe the almond emulsion, Spermaceti mixture, and opium, which will frequently be found remedies of the most decided efficacy.

In order to prevent the entrance of the discharge and blood into the trachea in particular instances, the plan has been tried of making the patient lie on his side, with his face turned downwards. (See Mém. de l'Acad. de Chir. tom. i. p. 581.) But, although the case here referred to ended well, we believe, as already explained, that nothing prevents the entrance of blood or matter into the trachea so effectually as keeping the edges of the wound of this tube accurately in contact, which is to be principally effected by bringing the chin down towards the breast. This is an object which is far more difficult of accomplishment, where the patient lies on his side, than when he remains, as is most usual, upon his back.

When a wound has detached the upper portion of the trachea from the lower one, and it is not immediately fatal from the injury of other important parts, the bleeding vessels are first to be tied, and the two ends of the trachea are then to be brought into contact. In this sort of case, we believe that the employment of a suture is warrantable, on account of the immense separation of the divided parts, and the inefficacy of position alone to prevent it. But, even in such a case, one suture will be quite enough when the chin is properly approximated to the sternum, and the needle should never be introduced through the membranous lining of the windpipe, as it is very sensible, and much disposed to inflammation.

The hoarseness and weakness of the voice, sometimes remaining after the wound is healed, often gradually disappear.

Many surgical writers recommend the patient to refrain from making forcible expirations, and from drawing the head suddenly backwards, for a certain time after the wound is healed. By such causes, it is asserted, the recent coalescence of the wound may be easily destroyed.

Wounds made with bullets, which strike the side of the neck and lacerate the trachea, have frequently been observed to terminate well. (Mém. de l'Acad. de Chir. tom. iii. p. 151, &c. edit. 12mo.) Ravaton mentions several instances, which not only got well, but were also followed by a recovery of the voice.

Sutures are not applicable to these cases. A strict adoption of the position recommended above, and the application of an emollient poultice contained in a fine linen bag, are the chief local surgical measures. The use of leeches, venesection, saline medicines, and antiphlogistic remedies of every description, will also be generally proper. (See First Lines of Surgery, p. 387. edit. 3.) Opium is likewise not to be forgotten as an extremely useful medicine in cases of wounds about the throat: it not only appeases the cough with which such injuries are often accompanied, but tends to quiet the great mental and nervous anxiety which in examples of attempted suicide existed previous to the infliction of the wound, and generally continues for some time afterwards in a very aggravated degree. Indeed, many of the unhappy persons who attempt to destroy themselves by cutting their throats, still retain for a good while after the failure of the first attempt, a determination to take another opportunity of accomplishing their fatal purpose; hence such patients cannot be too closely watched, and nothing like a razor or a knife should ever be put within their reach. The necessity of a constant vigilant attendant is also

also necessary, in order to hinder the dressings from being pulled off, and the wound torn open again, by the restless movements or actual violence of the patient.

In cases in which the whole diameter of the trachea is cut through, the French surgeons have proposed the introduction of a flexible catheter from one of the nostrils into the larynx and trachea, in order to insure a passage for respiration, which, they say, without this means is liable to be completely intercepted when the outer wound is closed, in consequence of the two portions of the windpipe being drawn away from each and not corresponding. (Richter, *Nosogr. Chir. t. iv. p. 170. edit. 4.*) This, however, would not be the practice to which we should give a preference; first, because the introduction of a flexible catheter is a thing which cannot always be accomplished with facility; secondly, because its use in this way is constantly productive of considerable irritation; and, thirdly, because we deem the employment of a future the best means of hindering one part of the trachea from becoming separated far from the other, and thus of insuring a passage for respiration.

With respect, however, to the introduction of a flexible catheter from one of the nostrils into the œsophagus, for the purpose of giving food and medicines to the patient, without any motion or disturbance of the wounded parts, we consider the method entitled to the highest praise in all cases of serious wounds, either of the larynx, the trachea, or the œsophagus. When a person swallows, the muscles concerned in the elevation and depression of the larynx act in a sudden convulsive kind of manner, and cause a most injurious disturbance of the wound. But when nourishment and medicines are injected into the stomach through a flexible tube, introduced from one of the nostrils down the œsophagus, this hurtful action of the muscles is entirely prevented; the instrument may be kept there without any annoyance or irritation, and the requisite quantity of aliment, and whatever internal remedies may be indicated, can be given with the utmost convenience. We consider this use of flexible catheters as constituting a very material improvement in the treatment of severe wounds of the throat. The military surgeon, in particular, should never be without these instruments; and whoever has read the relations of M. Larrey, in his *Mémoires de Chirurgie Militaire*, will see, that sometimes in bad wounds of the throat, the patient's chance of recovery depends almost entirely upon the aid to be derived from the skilful employment of an elastic gum tube.

Wounds of the œsophagus may either amount to a total or partial division of that tube; they may be either with or without a total division of the trachea; and with or without injury of other important parts in the vicinity. Hence such wounds are sometimes absolutely fatal; and, in general, when they admit of cure, nature has a greater share than art in bringing it about. Some benefit, however, is to be derived from good surgery, and infinite harm may result from bad.

A total division of the œsophagus must prove immediately fatal. The inevitable simultaneous injury of other important parts would render such a case at once mortal. The celebrated Prussian surgeon, Schmucker, has treated small wounds of the pharynx and upper part of the œsophagus with success. Wounds dividing half or even two-thirds of the tube are also stated to have been cured. (*Mém. de l'Acad. de Chir. tom. iii. p. 151. edit. 12mo.*) The possibility or impossibility of a cure must obviously depend upon what other parts of consequence are injured.

Incised wounds, which divide the front of the œsophagus, must derive additional danger from the simultaneous division

of the whole circle of the trachea; and, indeed, so much would the internal jugular vein, par vagum, and carotid artery, be exposed to the edge of the knife in a cut of this kind, that it is difficult to conceive how they can ever escape. Mr. John Bell, as we have seen, believed that they never could; and were it not for the many examples published, some of them by such a man as Default, and for an instance which was lately in St. Bartholomew's hospital, we should have joined Mr. J. Bell in thinking, that all reports of this kind were mistakes, arising from the wound extending through the root of the tongue into the mouth, and not actually injuries of the œsophagus itself.

A punctured wound, penetrating the side of the œsophagus, may not be complicated with injury of the trachea, and therefore may not be attended with so much peril as an incision. But although stabs injuring the œsophagus are not regularly and certainly mortal, they are always to be regarded as dangerous cases.

Should the case be one of those fortunate incised wounds which leave the great vessels uncut, though the injury of the œsophagus be complicated with a complete division of the trachea, the surgeon can lessen the space between the edges of the wound in the œsophagus by bringing the divided portions of the trachea together. This effect must result from the manner in which the posterior part of the windpipe is connected with the œsophagus. But for this purpose, a future is only to be used in such a state of the wounded trachea as amounts to a total division of the tube; for in all other cases, a proper position of the head, and the use of adhesive plaster to the external wound, should be the means with which the surgeon ought to be content, with a view of bringing the margins of the wound of the trachea near to each other.

In cases of wounds of the œsophagus, it was recommended, as long since as the time of Ravaton, to inject nourishment and medicines into the stomach, through a smooth tube of a suitable size, introduced down the pharynx. In one case of paralysis of the œsophagus, which occurred in this country, a small fresh eel-skin was passed down this canal, by means of a whale-bone probang, in order that medicines and food might be injected into the stomach. (Hunter, in *Trans. for the Improvement of Med. and Chirurgical Knowledge.*) The many cases, however, in which Default advantageously employed an elastic gum catheter for the same objects had a principal influence in establishing the practice. The instrument was introduced through one of the nostrils, and was often left in the œsophagus for several days together. (See *Œuvres Chir. de Default par Bichat, tom. ii.*) The introduction of elastic gum catheters down the pharynx and œsophagus is not only highly necessary in examples of paralysis, and wounds of those passages, but it is an exceedingly useful practice in wounds of the trachea, where the convulsive action of the muscles in deglutition would otherwise create a very hurtful disturbance of the injured parts. (*First Lines of Surgery, p. 38, 39. edit. 3.*) The practice is also sometimes absolutely necessary in many complicated wounds about the face, such as those produced by the discharge of a pistol into the mouth, and attended with extensive laceration of the tongue, cheeks, and fauces, and a comminuted fracture of the lower and upper jaw-bones. We believe, indeed, that in all fractures of the lower jaw, the introduction of a flexible catheter from one of the nostrils into the œsophagus is an extremely judicious measure, because the action of deglutition has a greater effect in displacing the broken bone and disturbing the process of union than any other circumstance.

Gun-shot wounds of the neck sometimes occasion an immediate loss of the use of the arm on the affected side; a circumstance which may in general be accounted for by the injury of some of the cervical nerves, in their descent to and from the axillary plexus. See Hennen's Military Surgery, p. 378, and Thomson's Report of Observations made in the Military Hospitals in Belgium, p. 75, 76.

Wounds of the Thorax, or Chest.—Some of these injuries penetrate the cavity of the thorax; others are more superficial, only affecting the skin and muscles, and not extending through the pleura costalis. When the latter cases are produced by sharp-cutting instruments, and the only indication is to accomplish an union of the divided parts, as happens in incised wounds of the skin, latissimus dorsi, pectoralis major, &c. such injuries are not materially different from any simple wounds of other parts of the body, and require a similar mode of treatment.

But where much violence has been applied to the parietes of the chest, and the concussion has operated so forcibly as to affect the heart, lungs, and other important organs, the wound, although simple in appearance and not penetrating the chest, may nevertheless be followed by alarming symptoms, either at first or consecutively; such as inflammation of the lungs, spitting of blood, and difficulty of breathing, as is frequently observed in contused and gun-shot wounds of the parietes of the chest. A violent blow on the dorsal vertebræ is also said to have given rise to a dilatation of the heart, and an aneurism of the aorta. Laffus, Pathologie Chir. tom. ii. p. 305.

Thus professor Thomson, in his account of the wounded whom he observed after the battle of Waterloo, remarks, "We saw more instances than one in which a ball, in passing across a portion of the parietes of the thorax, without penetrating that cavity, had excited an alarming and dangerous degree of inflammation of the pleura. In one of these, the ball had taken an oblique direction along the lower part of one of the sides of the chest. In another it had struck against a strong leathern belt that was suspended over the right shoulder, made a deep indentation in this belt without penetrating it, and produced a severely contused wound at the inner extremities of the first and second ribs of the right side. This patient suffered much from inflammation. The injured portions of the ribs had exfoliated and come out, and the motion of the lungs in inspiration and expiration was perceptible from the sinking and rising of that part of the parietes which had been deprived of its bony support. In another remarkable case, the ball entered above the middle of the clavicle, and passed out at a point directly behind. Neither at the first, nor at the time we saw this case, was there any reason to believe that the ball had wounded the pleura. Inflammation, however, of this membrane came on, which terminated in suppuration. The operation for empyema was performed, and about four pints of pus evacuated." Reports of Obs. in the Mil. Hospitals in Belgium, p. 82.

In wounds of the chest, it is often difficult to pronounce with certainty whether they penetrate into the sac of the pleura; but all doubts with regard to this point are removed the moment we observe air coming out of the wound upon coughing. That the lungs have been wounded may be inferred with nearly equal correctness in every case, in which a person spits blood immediately or soon after receiving a wound of the chest.

It rarely happens that a wound penetrates the cavity of the thorax without producing more or less injury of the lungs, and the danger of the latter accident is in proportion to its depth, its situation, and the size of the weapon with

which it was inflicted. A wound of the lungs with a small sword seldom gives rise to much effusion of blood in the chest, unless some of the large vessels of those organs happen to be hurt. Putting this circumstance out of present consideration, the usual symptoms which the patient suffers are, a spitting of blood, cough, and difficulty of breathing, succeeded by a good deal of symptomatic fever.

"To discover whether the wound has injured the lungs or not, (says a late writer,) is a point which has given to the older surgeons great room for employment of their ingenuity in devising possible cases, and has occasioned no small waste of time and wax-tapers in ascertaining the exit of air through the passage. A practical surgeon will require but little investigation; bloody expectoration immediately on receiving the wound, and the terrible symptoms of dyspnoea, sense of stricture and suffocation, insupportable anxiety and faintness which succeed, soon enough discover the fact; and if by good fortune no intimation is given in this way, happy is the surgeon, and thrice fortunate the patient.

"The immediate danger in wounds of the lungs is either from debility from hemorrhage, or suffocation from the blood flowing into the air-cells and cavity of the thorax. The effusion of air forming emphysema is also a troublesome, but (as Mr. Hennen believes), taking it abstractedly, is not a dangerous symptom of those injuries; neither (says he) is it by any means so frequent as has been supposed. The symptoms that I have now enumerated, whether single or in combination, may be deemed the primary effects of wounds of the thorax. Violent inflammatory affections of the lungs and the membranes ever subject to relapse; long and tedious suppurations and exfoliations of the bones are the secondary, and though not so rapidly fatal are often as certainly so as the others. Diseases which, although we cannot strictly call them pulmonary consumption, agree with it in many points, particularly in cough, emaciation, debility, and hectic, are often the consequences." Obs. on Military Surgery, p. 395.

When the weapon is broad, and it has entered the substance of the lung, the hemorrhage is considerable; blood is immediately extravasated in the cavity of the thorax, and also flows out of the external wound; the patient has a violent paroxysm of coughing, in which some of the blood is ejected from the mouth; the air comes out of the chest with a hissing noise; and if the outer wound be not parallel to that of the lungs, emphysema takes place. As we have already stated, the danger of such an injury depends upon the depth of the wound, and the size of the vessels which are opened. Some patients recover, while others die instantly, or in a very short space of time.

As an interesting author remarks, it is a thing really wonderful, "that the thorax, containing the heart, lungs, and great vessels, should be so often wounded with so little danger. Many no doubt die, but numbers escape; for a wound of the substance of the lungs is far from being mortal. The blood may suffocate the patient; the fever and pain may waste him; he may die of the inflammation, or of the oppression of the lungs; or there may be time for a large suppuration, or a lingering hectic to cut him off; but still, if his wound be only in the edges of the lungs, he is in some degree safe. He is only in danger when the thick substance of the lungs is perforated, and falls into abscess, or when the root of the lungs is wounded; for there the large vessels of the lungs being opened, the great effusion of blood, like that from a wound of the heart itself, must kill, even by the quantity of blood lost to the general system. But besides, this blood, being thrown into the trachea,

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trachea, deluges the lungs; the patient spits up a frothy blood; blood, instead of air, occupies the bronchiæ; so that he struggles for breath but a few moments, and then expires." John Bell's Discourse on the Nature and Cure of Wounds, p. 257. edit. 3.

We shall next consider the treatment of penetrating wounds of the chest. In these cases, the patient may die instantaneously of internal hemorrhage and suffocation; or he may be cut off by the effects of inflammation within the cavity of the thorax. If (says Mr. John Bell) the patient be spitting blood and breathing high, but not much oppressed, or his oppression increasing very slowly, there are hopes that he may be saved. If there be no great vessel wounded in the lungs so as to suffocate him at once, it is probable that the smaller vessels which are opened by the wound will gradually cease to bleed; and after four or five days of alarming cough, with bloody expectoration, that symptom will cease; and in order that he may the sooner be relieved from his danger, *he must be bled very freely*. Let it be the intention to reduce him very low by quick bleedings; and let these bleedings (says Mr. John Bell) have the effect of continued internal hemorrhage, without the dangers of it. Let them depress him to the same low condition to which the inward bleeding would most likely have brought him; and the system being emptied in this direction, there will be less danger of immediate suffocation in the lungs, and but little fear of the succeeding inflammation rising too high. It is only by these repeated bleedings that the patient can be saved: the vascular system must be kept low in action, and so drained as to prevent the lungs from being oppressed with blood.

One thing (continues the same author) is very clear, that if the surgeon bleed only when the cough and bleeding from the lungs return, he never can do wrong. The patient, lying struggling before him, is to lose a given quantity of blood; if it be allowed to flow out into the lungs he may be suffocated; if it be drawn from the arm, this suffocation is prevented. If he be kept low enough by bleeding, there will be no blood to spare for this extravasation into the lungs, &c. (Op. cit. p. 259, 260.) We repeat, in all cases of penetrating wounds of the chest, and especially in injuries of the lungs, the free use of the lancet is the only thing which can be depended upon in the early part of the treatment. By it, internal hemorrhage is restrained; and by it, the dangers of the subsequent inflammation of the thoracic viscera are to be averted. The records of surgery furnish abundant proof of the necessity of such practice, and the extent to which the bleeding must be carried is sometimes surprising. Thus, in a case in which a musket-ball had entered the left shoulder, passed through the lungs, and come out below the left nipple, a profuse hemorrhage of arterial blood took place from the mouth, and threatened immediate suffocation. This hemorrhage was checked by repeated bleedings, which were resorted to on every fresh attack of the hemorrhage, and pushed till relief was obtained. Leeches were applied to the side in great numbers, and the antiphlogistic plan of treatment was strictly pursued. Two hundred and fifty ounces of blood were in this case drawn off by the lancet in eighteen days. (See Thomson's Reports of Obs. made in the Military Hospitals in Belgium, p. 86.) In every instance of a penetrating wound of the chest, and more particularly when the lungs are injured, the first bleeding should be copious. As Mr. Hennen recommends, from thirty to forty ounces of blood should be taken from the arm by a large orifice. If the patient should faint, we ought not to administer cordials to him, but allow him to revive gradually. We should avail

ourselves of this opportunity of extracting without pain all foreign bodies within reach, whether cloth, ball, iron, wood, splinters of bone, &c. Should there be reason to think that such extraneous substances are lodged, and that by an enlargement of the orifice of the wound they might be extracted, the practice ought to be immediately adopted.

The next object is to dress the wound itself. "If it is a gun-shot (says Mr. Hennen), a light mild dressing will be sufficient; but if incised, the lips of it should be closed at once, and this treatment will be found to afford the most certain preventive to emphysema (see EMPHYSEMA), future hemorrhage, and collections of matter. (See EMPYEMA.) I scarcely recollect an instance where it was necessary to remove the adhesive straps, or (where it was a gun-shot) the usual dressings. We now lay the man down, and let him remain as quiet as possible, and in as cool and airy a spot of the barn, church, or hospital, as we can find. He will often require no farther aid; but if the case is very severe, he will probably lie for some hours in a state of comparative ease, till the vessels again pour forth their contents, and induce fresh spitting of bloody froth, and a repetition of all the symptoms of approaching suffocation. The lancet must again be had recourse to; and if by this management, repeated as often as circumstances demand, the patient survives the first twelve hours, hopes may begin to be entertained of his recovering from the immediate effects of hemorrhage. In the after-treatment of a wound of the nature here described, we shall be considerably assisted by the aid of medicine; but until the danger of immediate death from hemorrhage is over, we must not think of employing any thing except depletion by the lancet: it, and it only, can save the life of the wounded man." Hennen's Obs. on Military Surgery, p. 398.

When the paroxysms of pain, the sense of suffocation, and return of hemorrhage, says Mr. Hennen, have become more moderate, and recur at longer intervals, we may have recourse to means of less immediate influence, and spare the lancet. In this view, the most powerful medicine that we can administer is the different preparations of digitalis, in such form as may best agree with the patient; and if the pain and efforts to cough are severe and spasmodic, we must have recourse to the aid of opiates. To this course of medicine should be added a rigour of diet, amounting to the total prohibition of every thing solid, and admitting of fluids only of the mildest nature and least irritating quality; and even those in small quantities, and duly acidulated. Should we be fortunate enough to preserve our patient during the first six or seven days, a relaxation in this rigour may be cautiously admitted; but a departure from the general plan, or an omission of bleeding on the rising of the symptoms, can only tend to accelerate the event that our efforts are designed to counteract. Mild saline purges, and an emollient enema, should be occasionally administered if required, and the patient kept in a state of the utmost quiet and seclusion from all external impressions, and in a cool atmosphere. (Op. cit. p. 400.) The plan of exciting a counter-irritation on the surface of the chest, by means of blisters, should also never be omitted, when much cough and pain in the breast continue after bleeding has been fully practised. In some examples, the inflammation occasioned by penetrating wounds of the chest terminates in suppuration within the lungs, or the sac of the pleura. The symptoms, however, which indicate such an occurrence, and the mode of treatment, are so amply explained in another part of this work (see EMPYEMA), that we shall not enter into the subject again.

There is one circumstance which sometimes deceives the surgeon,

surgeon, and leads him to suppose that the case is a penetrating wound of the thorax when it is not so. We allude to the occasional examples in which a musket-ball pierces the skin and muscles on the outside of the chest, runs round the ribs, and makes its exit nearly opposite the point of entrance. Here the absence of bloody expectoration and other symptoms of injured lungs, together with the direction of the commencement of the track of the ball, will sometimes convey useful information to the discerning practitioner.

There is also another source of deception as to the actual penetration of balls into the cavities of the body: this is when they strike against a handkerchief, linen, cloth, &c. and are drawn out of the wound unperceived in a fold or pouch of those materials. M. Larrey, Mr. Hennen, &c. have published examples of the occurrence.

Wounds of the chest are sometimes complicated with the lodgment of extraneous substances in that cavity, and this sometimes without occasioning fatal consequences, either immediately or subsequently. Thus Mr. Hennen informs us, that in examining the bodies of soldiers who have died from those injuries, he has frequently found pieces of wadding, of clothes, spiculae of bone, and balls, and, in one case, some charpie used as a dressing, either loose in various parts of the lungs, or lying in sacs, formed by a deposition of coagulating lymph. In some more fortunate patients who recovered, such matters were discharged or extracted from the wounds; and in certain other lucky examples they were ejected by the convulsive efforts to cough, which their irritation had excited. (Obs. on Military Surgery, p. 390.) The same author relates the following interesting case, to prove that a much larger mass than a bullet may pass even through the lungs, without doing away all chance of recovery.

A soldier of the guards was wounded through the thorax at Waterloo, between the third and fourth ribs of the right side. On his arrival at Brussels, he was placed in an hospital and dressed. Nothing remarkable occurred for the first five days; and the only singularity in the appearance of the wound was its large size, capable of admitting three fingers conically placed. Blood and air were freely discharged from it. On turning the man to examine him, and renew the dressings, a tumour was discovered on the scapula, from which was extracted his breast-plate, about two-thirds of which were rolled up by the force of the blow into a figure somewhat resembling a candle-extinguisher, with the musket-bullet contained within it. The other third was broken off; but it had also passed through the wound, and was extracted. The man survived the injury three weeks, and afforded great hopes of his perfect recovery; but in a gust of passion, he one night tore the dressings off his wound, and was found dead the next morning. The body was not examined. Op. cit. p. 392.

Balls have been found in the substance of the lungs twenty years after their entrance, the patient being all that time in perfect health, without any symptom characterizing the peculiar situation of such foreign bodies. There are also on record instances in which a ball has rolled about in the cavity of the thorax on every motion of the body. (See Baron Percy's *Manuel du Chirurgien d'Armée*, p. 25; Magatus's *Bibliotheca Chirurgica*; and Hennen's *Military Surgery*.) In general, however, balls lodged in the thorax become as it were encysted and fixed by the deposition of coagulable lymph around them, and the formation of a sort of sac.

Several authors have noticed, that when a penetrating wound of the chest is of a certain size, a portion of the lungs

sometimes forms a protrusion between the ribs. In the majority of such cases, there can be no doubt of the propriety of immediately reducing this sort of hernia, and keeping it so replaced by means of a suitable apparatus. We learn, however, from the observations which have been collected on this subject, that the protruded part of the lung has sometimes been tied, or cut away, without any ill consequences. Fabricius Hildanus records the case of a man who was wounded with a sword between the fifth and sixth ribs, near the sternum, and in whom a piece of lung protruded. On examination it presented a livid appearance, and the discoloured part was therefore cut away with a heated knife. The rest was reduced, after separating the two ribs, from each other, as far as possible, by a wooden wedge. Notwithstanding this extraordinary method of treatment, the patient soon recovered, and lived without experiencing any oppression in respiration. See *Centur. 2. Obs. 32. p. 108.*

The livid appearance of the lung, as M. Lassus observes, arises from its exposure to the air, and the manner in which it is strangulated between the two ribs. It affords no proof either that the protruded part is gangrenous, or that it ought to be cut away. (*Pathol. Chir. tom. ii. p. 309.*) A writer (says he) who is very little known, and whose case we shall relate, confesses his having mistaken this livid discolouration for a sign of mortification. A man received a stab between the third and fourth ribs, on the right side of the chest, and by the way in which the sword had been withdrawn, the wound was rendered very large. A portion of the lungs protruded, swelled considerably, and remained in this state three or four days without any attempt being made to reduce it. The part then became shrunk and quite dry, when the whole of what was exterior to the ribs was cut off. On dipping the piece of lung in water, however, it immediately resumed its natural colour, which, no doubt, it would also have done had it been reduced instead of being amputated. The patient nevertheless got quite well, and suffered afterwards no difficulty, notwithstanding the hard laborious life which he was obliged to lead. *Obs. Medicinales et Chirurgicales par Loyer, p. 25.*

A similar mistake was made on a patient who had received a wound which penetrated the anterior and inferior part of the chest. A small bit of the lungs protruded, which was supposed to be a piece of omentum, and was immediately included in a ligature. Ruych being consulted, perceived the mistake, and he recommended dressing the wound, and leaving things as they were, until the tied portion of lung had become detached. No bad symptoms followed, and the patient perfectly recovered. (*Obs. Anat. Chir. obs. 53.*) We met with a protrusion of a long piece of the lungs in a soldier, who had been wounded with a lance at the battle of Waterloo. The part was at least four inches in length, and shaped like a tongue. As it was considerably contused and torn, we doubted the prudence of returning it in that state into the chest. We thought, therefore, of cutting it off, but fearful that it might bleed freely, we first made a small incision into it, in order to ascertain the fact; and as a good deal of blood began to flow from this little incision, we first tied the protruded part close to the ribs, and then removed all that was exterior to the ligature. The patient was so well on the day of the operation, and also the next morning, that he would not remain in bed; but we were informed that he did not ultimately recover.

A wound of one of the intercostal arteries immediately produces a degree of hemorrhage, which is manifest externally, and often considerable. The blood flows out of the wound, and also into the cavity of the chest. It issues

per saltum, like that of all wounded arteries, and it gushes out both in inspiration and expiration, but without any hissing noise, and not blended with mucus and air, like the blood which is discharged from a deep wound of the lungs.

We should not have expected much hemorrhage from the intercostal artery when wounded by a ball, much less should we have expected that it was ever possible to take up that vessel with a tenaculum. Yet a late writer observes, "whenever the tenaculum can be used to an intercostal artery injured by a ball, it should at once be applied, and the vessel secured by ligature." (See Hennen's *Obs. on Military Surgery*, p. 401.) Professor Thomson heard only of one hemorrhage from the intercostal artery after a gun-shot wound received at Waterloo, and this was a secondary bleeding on the fifteenth day. It was stopped by a compress. See *Obs. on the Military Hospitals*, &c. p. 83.

This sort of bleeding can only be stopped by compression, and in order that the plan may be effectually practised, it is sometimes necessary to enlarge the wound by an incision. When the finger is put under the wounded artery the bleeding ceases, which obviously proves that there is no occasion for needles, nor for any particular inventions for stopping the hemorrhage. According to M. Lassus, it will be quite enough to introduce between the ribs a tent, or dossil of charpie, which is to be kept in the wound four or five days. The bleeding having stopped, the wound will discharge for some days a reddish purulent fluid, and if the lung be not perceptibly injured, the cure will be speedily effected by ordinary treatment.

The method which has been tried for stopping hemorrhage from a wound of the internal mammary artery is analogous to the foregoing. A man was stabbed with a sword, which entered obliquely between the cartilages of the ribs. The wound was not extensive; but the effusion of blood in the cellular membrane of the lateral and anterior part of the thorax was considerable. An incision was made in the integuments covering the mass of blood, and several coagula were removed. The hemorrhage was then stopped by introducing some agaric, which was fastened to a spatula, and by means of this instrument, pressed from within outward, under the cartilage of the rib, near the side of the sternum. The wounded artery was thus very exactly compressed, and the plan was continued several days and nights successively under the direction of a surgeon. Lassus, *Pathol. Chir.* tom. ii. p. 312.

An extravasation of a considerable quantity of blood in one of the cavities of the pleura is followed by such a train of alarming and urgent symptoms, that the patient dies of suffocation unless the fluid be discharged. This may be accomplished either by making the patient lie on his wounded side, if the wound can thus be made depending, and it be sufficiently ample, or enlarging it with a bistoury, when it is too narrow, or by making another opening in the thorax when the wound is situated too high up. (See *EMPHYEMA*.) If the hemorrhage still continue, and be considerable, after the first extravasated blood has been discharged, the patient generally perishes; but when the bleeding ceases, and the lungs are not extensively injured, he may recover. Nothing but the urgency of the symptoms of suffocation, arising from a dangerous degree of pressure upon the lungs and diaphragm, can justify a hasty determination to make an opening for the evacuation of the extravasated blood, or the equally pernicious plan of leaving the original wound open for the same purpose. If the surgeon require arguments in support of this remark, they are to be derived from the equivocal, uncertain, and irregular character of the

symptoms of an extravasation of blood in the thorax, and from the effect which even the discharge of such blood may have in renewing the hemorrhage, and making room for another effusion, in cases where the injured vessels are large. The blood, however, must be discharged when the symptoms of suffocation are urgent, and evidently owing to the pressure of the extravasation on the organs of respiration. The practice of making an opening will always be unsuccessful, when the wound of the lungs, besides being deep enough to give rise to an extravasation, is also complicated with emphysema of those organs, and the effusion of a considerable quantity of blood into their cellular and parenchymatous texture. In short, in a wound of this serious description, it does not constantly happen, that the only curative indication is to discharge the extravasated blood. The degree of danger depends upon the nature of the wound of the lungs, which is invisible, and of which it is sometimes difficult to form a correct judgment. Frequently an extravasation of blood in the pericardium, without injury of the heart, but a case which is always fatal, has been mistaken for an extravasation in the cavity of the left pleura. Sometimes, also, we may be deceived, and believe in the existence of an extravasation, while the symptoms of suffocation under which the patient labours may be owing to the substance of the lungs being changed as it were into a solid mass, by the effusion of blood and coagulating lymph in their texture, and the consequent compression of the air-cells.

Although it must be acknowledged, that the diagnosis of an extravasation of blood in the chest is not free from difficulties, the following are usually regarded as the symptoms which characterize the case, either in the primary or secondary form. In the first place it is obvious, that there must generally be a wound of the lungs, which is indicated by the issue of frothy blood from the wound, by the passage of air through the wound into and out of the chest, and by the patient spitting blood, or coughing it up in large quantities. If, however, the blood come from the intercostal artery, no blood will be coughed up. At the moment of receiving the wound, the patient falls into a state of syncope, and though the bleeding may not be very considerable, he is affected with cold sweats, and his pulse is feeble and small. In the course of a few days, notwithstanding a low diet, repeated bleedings, and perfect quietude, respiration becomes short, difficult, and laborious, and inspiration is observed to be performed more easily than expiration. The patient usually lies upon the side in which the extravasation is; and this side seems rather larger and broader at its lower part than the opposite side, on which the patient cannot lie without an aggravation of all his sufferings. When he tries to sit up in bed, he cannot remain in this position, unless he bends his body very much forwards, in order to facilitate respiration. About the xiphoid cartilage and the lateral parts of the chest, he feels a weight, attended with a frequent cough, and a sensation of suffocation. According to Valentin, a large ecchymosis, or violet-coloured spot, makes its appearance in some individuals in a later stage of the case about the angles of the false ribs; but this symptom is far from being constant, and it did not occur in an instance of extravasation of blood in the thorax recorded by Dr. Thomson. (Reports of Observations made in the Military Hospitals in Belgium, p. 85.) In general, blood escapes from the wound, unless the opening be very small, or situated in the upper part of the chest. Lastly, it is remarked, that the symptoms of suffocation proceeding from inflammation of the lungs subside, or are evidently lessened by venesection, which is not the case when they depend upon an extravasation.

If it be true that some patients have had their breathing very little oppressed, notwithstanding an extravasation of blood in one of the cavities of the pleura, and that others have been able to lie with equal ease either on the sound or diseased side (see Thomson's Report, p. 87.), which is not common, we must conclude from these unusual cases, that we ought not to form our opinion from any one symptom in particular, but from the assemblage of a great many. Laffus, Pathol. Chir. tom. ii. p. 319.

On the subject of extravasations of blood in the thorax, the following are the sentiments of a distinguished writer: "Whatever may be the cause of this inward bleeding, the surgeon should attend to the following directions. He should first put his finger into the wound; perhaps it may discover the cause, or may evacuate the blood. If the blood do not follow the finger, then some tube must be introduced, and the tube for so simple an operation need not be a nice one. If he cannot get the tube into the thorax, and the breathing continue oppressed, he must enlarge the wound, and enlarge it freely. To be afraid of exposing the lungs to air when they are already torn with a bullet and loaded with blood is childish and useless theory, very unlike the proper management of such wounds. If the wound in the thorax be not too high above the third or fourth rib, and if no posture of the patient, however willing or able to turn himself, will bring the blood easily in that way, or if the wound be contused, oblique, and difficult to dilate, an operation must be performed, which, as it is commonly practised for pus in the breast, is called the operation of *Empyema* (see this word); that is, a very free incision must be made in the line betwixt two of the ribs; then the pleura must be punctured with a lancet, and a tube introduced. Or, in plain language, whenever it is found that the natural wound will not empty the thorax, a new wound should be made in what is called the chosen point, or the point of election, *i. e.* low, betwixt the seventh and eighth ribs, that there may be an easy flow. But whenever the wound is about the middle of the thorax, it should rather be dilated, which both changes the nature of the wound and gets out the blood. When this blood proceeds from a wound of the intercostal artery, such free incisions are the more necessary; they allow us to see the artery, to feel the jet of its warm blood by putting in the finger, and this allows us to press it with a compress, or tie it with the needle and thread." (See John Bell's Discourses on Wounds, p. 263, 264. edit. 3.) However, notwithstanding this author, and a few other surgeons thus talk of taking up the intercostal artery, we much doubt the possibility of the thing, nor do we know of any well-authenticated case on record where it has actually been done.

The propriety of some other parts of this advice is also questionable, especially that relating to thrusting tubes into the cavity of the thorax. The necessity of cutting into the chest at all in order to let out extravasated blood, in an early stage of a wound of the thorax, is positively denied by Scarpa, as we shall find from an extract we shall have to make from his work in speaking of wounds of the belly. On the contrary, Scarpa, Larrey, Assalini, Hennen, &c. all agree, that wounds of the chest should be closed, and superficially and lightly dressed. At all events, we may safely assert, that in these cases nothing but the urgency of the danger, unequivocally arising from the pressure of the mass of extravasated blood on the organs of respiration, can ever justify the practice of either making another opening into the chest, or of enlarging the original one. Of the method of keeping the wound open with tubes or tents, we have a very unfavourable opinion.

In every case of extravasation of blood in the chest, the discharge of it when respiration is dangerously oppressed is not the only indication. There is another one of at least equal importance: we allude to the adoption of a rigorous antiphlogistic treatment, in order to avert and diminish the dangers arising from inflammation of the pleura and lungs.

Besides extravasation of blood in the cavity of the pleura, there is another complication which sometimes attends wounds of the chest, and is particularly deserving of the attention of the practitioner. We mean the case of emphysema, or what Mr. John Bell calls "the tumour formed by air blown out from the lungs into the common cellular substance, or confined within the thorax, and oppressing the lungs." It is not, however, our wish to detain the reader long on this interesting disorder, because by turning to the article EMPHYSEMA, he will find a statement of all the principal knowledge which exists upon the subject.

Emphysema arises from the air escaping, first from the lungs into the thorax; then from the thorax through the wound in the pleura costalis into the cellular substance on the outside of the chest; and afterwards, the air inflates the cellular membrane over the whole body. As Mr. John Bell has related, emphysema is frequent after a fractured rib, because there is a wide laceration of the lungs, and no exit for the air; while it is less frequent in large wounds with a knife or broadsword, because in such cases the air has an open and unimpeded issue. It is very common after deep stabs with the bayonet or smallsword; and it sometimes arises in gun-shot wounds, though, as far as our experience extends, it is not so frequent in these particular instances, as Mr. John Bell describes. Mr. Hennen thinks it does not occur in more than one case out of fifty (p. 402.), which is, perhaps, a calculation considerably below the real state of things.

When the lungs are wounded, the air escapes from them at every inspiration into the cavity of the pleura, whence the next expiration it is compressed, and forced through the breach of continuity in the pleura into the cellular substance on the outside of the chest; for it cannot return into the wounded lung, because this is already full. Every new inspiration draws more air from the wounded lung, and every new expiration drives more air out into the cellular substance. There is no other outlet for the air, which spreads under the skin with wonderful rapidity. The emphysematous crackling tumour makes its first appearance over the broken rib, or over the wounded point of the thorax; it then extends over the whole chest, and next over the neck and face, filling particularly the eye-lids, so that the eyes are absolutely closed. It afterwards extends itself over the belly, down the thighs, and to the private parts, and no part escapes this tumour, except the palms of the hands and the soles of the feet. More air is every moment drawn out from the wound of the lungs, and driven under the skin; and the patient is every moment more and more oppressed, till at last the breathing is quite interrupted, the pulse flags, the extremities grow cold, and the patient, if he be not relieved by some operation, must die. John Bell, p. 267, 268.

The moment that the lungs are wounded, (says this author,) they fall down, and continue in this collapsed state until the wound heals, which it does in the course of a very few days; but from the moment in which lungs are wounded, the use of the wounded lobe is lost, so that if the wound be in the right side of the lungs, the breathing is performed entirely by the left; only half the quantity of air is inspired, and the breathing is difficult.

If the lungs, when wounded, were to continue in perpetual

tual motion, (says Mr. J. Bell,) I do not know how we should expect a cure; for the air would be continually streaming through the wound, and the wound itself alternately dilating and contracting, like that in an artery, could not heal. But as the wounded lung lies in a collapsed state, the edges of the wound are in contact with each other. P. 269.

That the lung of one side, which remains unhurt, is sufficient to support the system, we learn from various accidents; from those cases in which, either owing to the incisions made by the surgeon, or to the nature of the wound, the chest has been freely opened, the lungs of one side have collapsed, and yet the patient has lived with tolerable ease, and ultimately recovered. We learn it also from cases of emphysema, where the lungs are oppressed with air, and from cases of empyema, or pus, within the cavity of the chest, obstructing the expansion of the lungs. (See EMPYEMA.) And especially, (says Mr. J. Bell,) we are sure of it from the very gradual decay of those who die with large suppurations within the chest, in whom we find after death, that on one side there remains nothing but one small knob or tubercle of the lungs. Koelpen de Empyemate Obf. P. 135.

That the breathing should be easier in a free and open wound of the chest than in a punctured wound, or that in the case of a punctured wound the patient should be relieved by a free incision, no one need wonder; for in a punctured wound there is no way for the blood or air to escape from the thorax, while yet at every stroke of respiration, more and more blood and air is drawn out from the lungs, till at last the blood, and especially the air, are so condensed, that they not only oppress that side of the lungs, but by hindering the free play of the diaphragm, and loading the mediastinum, they oppress also the other lung, the difficulty of breathing increases, the extremities grow cold, and the patient dies.

Whatever danger then depends altogether upon emphysema itself depends upon the manner in which the confinement of air in the chest oppresses not only the wounded, but also the opposite lung, the diaphragm, &c. The extensive inflation of the cellular membrane in other parts of the body is a circumstance which creates a terrible disfigurement, but perhaps very little peril in itself. Sometimes, however, it proceeds to such a pitch, that even the interstitial cellular substance of the lungs themselves becomes inflated, and then suffocation is inevitable.

On the treatment of emphysema we shall merely remark at present, that the chief means, both of relieving the organs of respiration from compression, and of hindering the further increase of the diffusion of air in the cellular membrane, consists in practising an incision in the thorax at the part where the air first escapes from that cavity. For other practical observations we refer to the article EMPHYSEMA.

The existence of adhesions between the pleura costalis and pleura pulmonalis, previously to the receipt of a wound of the chest, must make an important difference with regard to the subsequent state of the lungs, and particularly with regard to their condition in the case of emphysema. Such adhesions must of course render a collapse of these organs impossible, and also prevent the air from insinuating itself between the surface of the lungs and the inside of the chest. Whether these occurrences can be perfectly prevented will of course depend upon the extent of the adhesions. They would, however, be certainly averted altogether, were the wound to happen just at a part of the chest where the pleura costalis and pleura pulmonalis happened to be adherent.

From some remarks which have been delivered, the reader will see, that wounds opening both cavities of the chest, unless

such adhesions exist, must produce immediate suffocation, in consequence of both lungs becoming collapsed. That this would really happen is the belief of the majority of the best modern writers, and there are several facts reported which tend to confirm the accuracy of the opinion. A late author, however, conceives, that the sinking of the lung is not an uniform consequence of a penetrating wound of the thorax. He observes, that we have sometimes ocular proof of this, not only by the close contact in which the lungs lie to the wound discoverable at first sight, but by protrusions which occasionally happen. From experiments on brutes, says he, we derive no satisfactory elucidation; for in some, where incisions on each side have been made through the intercostal muscles, much greater than the natural passage of the air, the lungs, so far from collapsing, have expanded again, the animal has lived, and in ten days run about as well as ever. And in our own species, the recoveries from wounds of the thorax on both sides, larger than the orifice of the glottis, dangerous as they are, are not few. Hennen's Obf. on Military Surgery, p. 404, 405.

Wounds of the heart generally prove immediately fatal, though it is true there are to be found in the records of surgery many curious exceptions to this observation. A soldier received the thrust of a sword, which entered one of the cavities of that organ, as was ascertained after death; yet he lived nine days after the accident. (Rhodius, Obf. Medic. centur. ii. obf. 39.) A young man, twenty-six years of age, was stabbed with a sword in the right side, between the third and fourth true ribs. He became exceedingly weak, had great difficulty of breathing, and died in four or five days. On opening the body, it was discovered that the heart had been completely transfixed, the weapon having passed from the right into the left ventricle, through the septum. The cavity of the chest was full of blood, and it was thought that the prolongation of life had been owing to the closure of the wound with coagula. (Saviard, obf. 113.) Haller, as Mr. Hennen observes, has recorded in his Bibliotheca Chirurgica, vol. ii. p. 378. an example in which a needle was found in the heart of an ox; and through the kindness of Mr. Hammick, surgeon of the royal naval hospital at Plymouth, Mr. Hennen was lately shewn a preparation, in which a pin was lodged in the human heart, but without any trace of the mode in which it got there. The patient had complained of a pain in his chest, about three months previously to his death, and died of carditis. (Obf. on Mil. Surgery, p. 429.) Ploucquet gives instances in which a ball was lodged in the heart of a stag, in the heart of a healthy dog, and in the anterior ventricle of the human heart, where it is stated to have remained for years. Another instance has also been recently published, in which a ball was found lodged in the right ventricle of the heart, near its apex, included in a great measure in the pericardium, and resting upon the septum. See the article *Cas Rares*, Dict. des Sciences Medicales.

Guattani mentions a case in which a patient lived eight years after a wound of the aorta (*De Aneurismatibus*); and in the Medical Records and Researches, 1798, is the extraordinary case of a penetrating wound, in which a bayonet passed through the colon, stomach, diaphragm, part of the lungs, and the right ventricle of the heart, and yet the patient survived the accident for upwards of nine hours. Mr. Hennen also refers to another instance, related by M. Chaiffenet, of a wound of the right ventricle, which did not prove fatal till the 15th day after the injury. (See Journ. de Med. Militaire, Paris, 1782, tom. ii. p. 359.) For additional observations on this subject, however, we must be content with referring to Mr. Hennen's publication.

WOUNDS.

As wounds of the diaphragm can hardly happen without the simultaneous injury of several other important parts, these cases must necessarily be attended with considerable danger; and indeed, when the tendinous centre of the diaphragm is injured, the accident is deemed by several writers of modern date as inevitably fatal. (Lassus, *Pathol. Chir.* tom. ii. p. 321. Callisen, *Syst. Chir. Hodiernæ, Pars ii.* p. 696.) The following are said to be usual symptoms of a wound of the diaphragm:—The patient is immediately seized with excessive anxiety and agitation. He feels acute pain in the hypochondria, and is obliged to keep himself bent forwards; and he is further afflicted with a cough, hiccough, convulsive spasms, and great difficulty of breathing. Delirium ensues, the muscles of the face are convulsed, the singultus grows worse and worse, and the case terminates fatally in the course of a few days.

Dangerous, however, as wounds of the diaphragm must generally be, on account of their being for the most part complicated with injury of some of the abdominal or thoracic viscera, there is no doubt that the danger has been exaggerated. “Wounds of the thorax (says Dr. Thomson) are not unfrequently complicated with wounds of the abdomen. In various instances of this kind (which this gentleman saw in the Netherlands after the battle of Waterloo), there existed undoubted proofs of the fact that wounds of the diaphragm are not necessarily fatal; for it must have been perforated once, if not twice, in several of the cases we saw, in which balls had passed across the lower part of the chest, and the same thing must have happened also, I conceive, in most of the cases in which the liver had been wounded. In one case, the ball had entered the right hypochondriac region, under the edge of the false ribs, and come out on the right side of the spine, on a level with the superior edge of the os ilium. This patient spit blood for some days, and voided it also by stool. On the examination after death of a patient who died thirty days after receiving the wound, and in whom a ball had entered the chest on the lower and outer part of the right papilla, and had come out of the abdomen on the left side of the umbilicus, the right lobe of the lung was found wounded, and the diaphragm and the upper part of the right lobe of the liver perforated. But neither in these cases, nor in several others of wounds of the diaphragm which we saw, did any peculiar symptoms, such as the risus sardonius, or convulsive motions of the chest, present themselves to our notice.” See Report of Obs. made in the Mil. Hospitals in Belgium, p. 93.

In the treatment of wounds of the diaphragm, abstractedly considered, very little can be done; bleeding and antiphlogistic remedies appear the only means which promise any effectual good. With these, however, we may sometimes usefully conjoin opiates.

Extensive wounds and lacerations of the diaphragm occasionally give rise to a particular and incurable species of rupture, in which some of the abdominal viscera form a protrusion in the cavity of the chest. This accident is termed a phrenic hernia, and some account of it will be found in the article **HERNIA**.

Wounds of the Belly, or Abdomen.—Wounds of the abdomen are divided into two principal classes: in one the solution of continuity is confined to the integuments, muscles, &c. exterior to the peritoneum; in the other this last membrane is penetrated, and frequently some of the viscera also which are included in it. Wounds affecting the parietes of the abdomen, but not extending through the peritoneum, whether of the punctured, incised, or contused kinds, have no essential difference from wounds of other parts, and the observations which have been offered on the subject of wounds

in general are in every respect applicable to all superficial wounds of the belly. It is worthy of remark, however, that the parietes of the abdomen are always weakened in consequence of wounds, and disposed to allow the viscera to form protrusions. Strong as the cicatrix may be, the point where it is situated continues subject to a hernia, which seldom fails to occur, unless the weakened part be properly supported with a belt or bandage. This accident may follow a simple punctured wound; but it invariably takes place in every instance where, in consequence of a severe contusion, the parietes of the abdomen have lost their tone, and yield to the impulse made against them by the parts which they contain. It was thus that a cooper's wife, whose history is given by Sennertus, after being violently struck on the abdomen by a piece of green elastic wood, which slipped out of her husband's hands, suffered such a relaxation of the contused part, that the anterior parietes of the abdomen yielded so as to form an enormous pouch, containing, during pregnancy, the gravid uterus itself.

After accomplishing the re-union of a superficial wound of the belly by means of an eligible position, adhesive plasters, and a bandage, we should therefore recommend the patient to wear a belt, or any other means of making pressure on the part which must be supported. Should the wound have been confined to the skin, however, and the muscles not have been at all divided, there would be no risk of a hernial protrusion afterwards, and of course the use of a belt, or any sort of bandage, would then be unnecessary.

If superficial wounds of the abdomen are unattended with any particular danger or peculiarity, the same observation cannot be made with respect to penetrating wounds, or those which pass through the peritoneum. We have seen that penetrating wounds of the chest give rise to a variety of dangers, sometimes depending upon the effusion of blood into the bronchiæ and air-cells of the lungs, or into the cavity of the pleura; sometimes upon the consequences of that extraordinary complication emphysema; but more especially upon the great tendency of the pleura and lungs to inflammation. The principal dangers of penetrating wounds of the belly arise also partly from internal hemorrhage within the cavity of the peritoneum; partly from the irritation which is produced by the occasional extravasation of the contents of the viscera; but in a still greater degree, from the strong disposition of the peritoneum to become affected with violent and extensive inflammation, in consequence of any injury or irritation. There are, says Mr. John Bell, a thousand occasions on which this delicacy of the peritoneum may be observed. The wound of the small sword, and the stab of the filetto, explain to us how quickly the peritoneum, and all its contained bowels, inflame from the most minute wound, although it be almost too small to be visible on the outside, and scarcely within; for, upon dissection, no intestines are seen wounded, and no feces have escaped into the abdomen. In those who die after lithotomy, we find the cavity of the peritoneum universally inflamed. The operation of Cæsarean section is fatal, not from any loss of blood, for there is little bleeding, nor from exposure to the air, for they also die in whom the womb bursts, and where the air is not allowed to enter; but merely from that inflammation which succeeds to wounds of the peritoneum, small as well as great, of which we have sometimes a melancholy proof in the operation of hernia, in which the stitching the wound, according to the whimsical improvement of some modern surgeons, or where the mere tying of the sac, as in the practice of the old rupture-doctors and castrators, often raised such inflammation as spread very quickly over the abdomen, and ended in gangrene.

grene. This inflammation may, no doubt, come on from the slightest scratch in the peritoneum itself; yet, in general, it arises rather from the wound of some of the viscera. If an intestine be wounded, it may pour out its feces into the abdomen; if the liver, spleen, or kidneys be wounded, these pour out blood; if the bladder, then the urine filters into the cavity of the belly. The extravasated food, feces, urine, blood, &c. act there as irritating extraneous substances, which no activity of the absorbents can remove, and which soon cause a fatal inflammation of every peritoneal surface within the abdomen. See John Bell's Discourses on the Nature and Cure of Wounds, p. 310. edit. 3.

Apprized by melancholy experience of the vast difference which the penetration of the peritoneum makes in the nature of a wound of the abdomen, surgeons have betrayed considerable anxiety to be able to ascertain at first, in every instance, whether the injury partakes of this serious description or not. But although the nature of the case is self-evident, when the wound in the parietes of the abdomen is large, and attended with protrusion of the viscera, it is often extremely difficult to judge whether the weapon has gone through the peritoneum or not, when the wound is a simple stab, unaccompanied with protrusion of the viscera, or with any effusion of their contents.

The generality of surgical authors have laid down a variety of criteria for determining the question, whether the case is a penetrating wound? Some of these writers lay much stress on comparing the direction of the wound with the natural thickness of the parietes of the abdomen at the injured part, and the breadth of the injury with that of the weapon. When the instrument has acted perpendicularly upon a point, where the parietes are thin, and the wound, though made with a narrowish weapon, like a sword, is yet of a certain breadth, there can indeed be little doubt of the case being a penetrating wound. But the impossibility of knowing in what direction the thrust has been made, and of procuring the weapon, in order to compare its diameter with that of the wound, generally renders this mode of discrimination useless in actual practice.

If a probe (say other writers) will readily enter perpendicularly to a certain depth, in a place where the parietes of the abdomen are thin, the circumstance is a proof that the case is a penetrating wound. But if the probe cannot be thus introduced, we are by no means justified in concluding that the wound does not penetrate. As the layers of muscles do not bear the same relative position to each other which they did at the time of the accident, they soon stop the passage of the probe; and in whatever posture we put the patient, it is next to impossible to put the parts exactly in the same position in which they were at the time of the receipt of the injury. Besides, when the wound is oblique, a probe which is not very flexible cannot easily be made to follow its track. The employment of this instrument is also not free from objections, founded on its creating pain and irritation, or even a renewal of hemorrhage and effusion of blood in the cellular membrane.

An absurd proposal has been made to inject a mucilaginous fluid into the wound, the passage of which into the belly would be a sure indication of the cavity of the abdomen being penetrated. It is obvious, however, that the injected liquid may not enter, though the case be a penetrating wound, owing to the change in the relative position of the layers of the abdominal muscles. The fluid may also continue in the wound in consequence of its passing into the cellular substance; and thus it may make the surgeon suppose that it enters the abdomen, when in reality it does not pass down even to the peritoneum. Nor can the mildest injection

be thus thrown into the cavity of the peritoneum without the utmost risk of exciting that fatal kind of inflammation which we have already mentioned, as the danger most to be dreaded in all wounds of the abdomen.

The signs then of a penetrating wound of the abdomen are fallacious, and the employment of such means as the probe and injections, with a view of ascertaining the real nature of the case, is not exempt from danger. Many spasmodic affections, which occasionally follow the receipt of a wound of the belly, are only equivocal, as they are sometimes owing entirely to the great sensibility of the patient. The protrusion of the abdominal viscera, and the discharge of fluids which they are known to contain, are the only sure signs of a penetrating wound. It is easily conceivable at the same time, that a wound may penetrate the cavity of the belly, and yet these symptoms may not occur, either because the external wound is too small to allow of the escape of any of the viscera or their contents, or because the weapon or ball, after piercing the peritoneum, has actually touched none of the bowels, or has merely glided over their surface. But penetrating wounds, which are unattended with protrusion of the viscera, or extravasation of any fluid in the cavity of the abdomen, are less alarming than several complicated wounds which do not penetrate. If in such case, says Richerand, the patient or bystanders were to inquire about the nature of the injury, we should avoid giving a positive opinion, informing them of the insufficiency of the means formerly practised, in order to ascertain the precise depth of the wound, and explaining the objections to the probe and injections. It should also be mentioned to them that the antiphlogistic treatment, which is the best in simple wounds which do not penetrate, is the only plan which could be adopted, were it certain that the injury had extended into the cavity of the abdomen. *Nosographie Chir.* tom. iii. p. 327—335. edit. 4.

In the following description of the treatment requisite for the different cases of penetrating wounds of the belly, we shall follow the order chosen by M. Richerand, and consider,

First, the cases in which the viscera, though uninjured, protrude at the wound.

Secondly, the cases which are complicated both with injury and protrusion of the viscera.

Thirdly, penetrating wounds unaccompanied with protrusion, but yet attended with injury of one or more of the viscera, as is indicated by particular symptoms, and especially by the issue of certain kinds of matter from the external wound.

And lastly, we shall conclude with noticing the subject of extravasations, and some wounds of particular organs and viscera.

1. *Of Wounds of the Belly, attended with Protrusion of the Viscera.*—When, in consequence of a division of the parietes of the abdomen by a cutting instrument, or their laceration by a bull's-horn, the intestines protrude between the lips of the wound, the first indication is to reduce the parts, and then to take measures for preventing a recurrence of the protrusion. The reduction is generally easy, if care be taken to relax the abdominal muscles by a judicious posture. In some cases, however, the wound is so narrow that the thing is more difficult, and here, instead of puncturing the bowel, in order to diminish its size by discharging the air which it contains, (as advised by many writers,) we decidedly recommend a moderate enlargement of the wound. This should be cautiously executed with a probe-pointed curved bistoury, introduced along the groove of a director; or, if there be room, under the guidance of the left finger.

finger. In this manner, and with due care, the wound may always be sufficiently dilated without the protruded parts being cut. Authors also recommend the incision for this purpose to be directed upwards; for (say they) the further the cut is from the lower part of the belly, the less liable will the patient afterwards be to hernia. The intestines should invariably be returned without delay, in every instance in which they are free from wound or gangrene. Should they even be slightly wounded or inflamed, no time should be lost in absurdly applying fomentations, &c. to them in their protruded state. The natural warmth and moisture of the cavity, into which they are to be replaced, will be far more congenial than any topical remedies. Should the parts, however, have any dirt or sand upon them, the most which ought to be done before their reduction is to wash them with warm milk and water.

The reduction having been effected, the patient is to lie upon his back, with the thighs bent upon the pelvis, and he must strictly avoid making any exertion, lest it bring on another protrusion. The wound is to be closed with adhesive plaster, and the uniting bandage; but if the wound should be large, and these means ineffectual, it would also be proper to employ sutures. The stitches, however, should always be as few as possible. This method of sewing up wounds of the belly made a long subject in all the old works on surgery, under the appellation of *Gastroraphe* (see that article); but at the present day, sutures are comparatively speaking almost rejected from practice, or are only employed when the opposite surfaces of wounds cannot be kept in contact without them. Nor are they then ever used, except the chance of union by the first intention still forms a temptation for the trial of the plan; for when a wound must heal by the granulating process, stitches can never be of the least utility.

When the omentum protrudes through a penetrating wound, and is strangulated by the narrowness of the opening, it soon contracts adhesions. Richerand recommends us to cut off all this membrane which exceeds the level of the integuments, and to leave in the wound the rest, which, he asserts, will act like a stopper, and hinder future herniæ. Were the wound, however, quite recent, so that adhesions could not yet have formed, the propriety of dilating the opening, and reducing the piece of omentum, would be unquestionable. Whenever, also, the omentum is found, and free from constriction, it should be reduced. In cases where a portion of this membrane is not only protruded, but gangrenous, writers authorize the excision of the dead part, and reducing the rest after the cut vessels have been tied singly with small silk ligatures. We apprehend, however, that in general, whenever the omentum has been out so long as to slough, adhesions within the wound have had time to form; an event which would embarrass the operator, and even render the safety and propriety of the attempt to reduce the living portion of the protruded membrane very questionable. Should the omentum, or intestine, however, be not adherent to the neck of the hernial sac, though gangrenous, (as occurred in an instance cited by Scarpa, *Traité des Hernies*, p. 268.) the propriety of trying to reduce it would be undeniable.

2. *Wounds of the Belly, with Injury and Protrusion of the Viscera.*—Penetrating wounds of the abdomen, attended with protrusion of the intestines, are always to be regarded as dangerous cases; but the danger is much more serious, if, besides being protruded, the bowels are also wounded. Under such circumstances, we have the authority of numerous writers on surgery, as a sanction of the practice of sewing together the edges of the division in the protruded

intestine; a practice, however, which, as we shall hereafter explain, does not meet with the approbation of that excellent modern surgeon, professor Scarpa, of Pavia. Every one, however, allows, that the attempt would be highly improper and rash, were the bowel only wounded, without forming a protrusion. It is this last occurrence which creates a material difference in estimating the possibility of the plan, the question of its necessity being at present excluded from consideration. When the parts are protruded, no enlargement of the external wound is necessary to render the application of a future practicable; the plan creates no disturbance and irritation of the peritoneum and contiguous viscera; there is no doubt concerning the actual existence of the injury, no difficulty in immediately finding out its precise situation.

But though many authors are so generally agreed about the propriety of using a suture in the case of a wounded and protruded bowel, they differ exceedingly, both as to the right object of the method, and the most advantageous mode of making the stitches. Some, having little apprehension of extravasation after the reduction of the gut, advise only one suture to be made, (frequently only through the mesentery,) and they employ the ligature chiefly with a view of confining the injured bowel near the external wound, so that whatever part of its contents may be effused, there will be a ready passage for the matter outward. Other writers wish to remove the possibility of extravasation, by applying numerous stitches, and attach little importance to the plan of using the ligature, principally for the purpose of keeping the intestine near the external wound.

When the wound of a bowel is so small that it is closed by the protrusion of the villous coat, the application of a suture must evidently be altogether needless; and since the ligature could not fail to cause irritation, as an extraneous substance, the employment of it ought unquestionably to be dispensed with.

Supposing, however, the breach in the intestine to be small, but yet sufficient to let the feces escape, what method ought to be adopted? The following practice has been tried. As Mr. A. Cooper was performing the operation for a strangulated hernia, at Guy's hospital, an aperture, giving issue to the intestinal contents, was discovered in a portion of the sound bowel, just when the part was about to be reduced. The operator, including the aperture in his forceps, caused a fine silk ligature to be carried beneath the point of the instrument, firmly tied upon the gut, and the ends cut off close to the intestine. The part was then replaced, and the patient did well. Mr. Travers, who has related this fact, approves of the plan of cutting away the extremities of the ligature, instead of leaving them hanging out of the external wound. It appears that when the first practice is followed, the remnant always finds its way into the intestine, and is discharged with the stools, without any inconvenience. But when the long ends are drawn through the outer wound, and left in it, they materially retard the process of healing. See Travers's *Inquiry into the Process of Nature in repairing Injuries of the Intestines*, &c. p. 112, 113.

Let us now inquire what ought to be the conduct of a surgeon, were he called to a patient, whose bowel is divided through its whole diameter, and protruded at the external wound? Various have been the schemes and proposals for the treatment of this sort of accident; and since experience has furnished few practitioners with an opportunity of seeing such a case in the human subject, a variety of experiments have been made on animals, in order to determine what treatment would be the most successful. Ramdohr, indeed,

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is stated by Mœbius to have had occasion to try on the human subject a plan, on which a vast deal has been said and written. He cut off a large part of a mortified intestine, and joined the sound ends together, by inserting the upper within the lower one, and fixing them in this position with a suture; the ligature being also employed, to keep them at the same time near the external wound. The patient recovered, and the feces afterwards passed entirely by the rectum in the natural way. See Haller's Disputat. Anat. vol. vi. Obs. Med. Miscellan. 18.

About a year after the operation, the patient died, when the anatomical preparation of the parts was sent by Ramdohr to Heister. They were preserved in spirits of wine, and exhibited, according to this last author, an union of the two ends of the bowels together, and their consolidation with a part of the abdomen. Now it has been questioned by a late writer, whether the union here spoken of ever really happened. When the upper end of the bowel is introduced into the lower, the external surface of the former is put in contact with the inner one of the latter; a serous membrane is placed in contact with a mucous one. These heterogeneous structures, he alleges, are not disposed to unite. The mucous membrane, when inflamed, more readily secretes a kind of mucus, which must be an invincible obstacle to adhesion. He thinks it, therefore, more than probable, that, in the case related by Heister, the invagination was maintained by the union of the intestine with the corresponding part of the abdominal parietes. Several experiments on living animals have convinced him that this happens, and that the mucous membrane will not unite with the external peritoneal coat. This impossibility of producing an immediate union between mucous and serous membranes may, of course, be urged as an objection to Ramdohr's practice. (Richerand, Nosographie Chirurg. tom. iii. p. 344. edit. 4.) Another equally strong objection is, that the upper end of the bowel cannot be put into the lower one, unless it be separated from a part of the mesentery. Here the division of the mesenteric arteries may cause a dangerous bleeding. In vain did Boyer tie seven or eight of these vessels: his patient died with an extravasation in the abdomen. (Op. cit. tom. iii. p. 343.) Mœbius attempted to repeat Ramdohr's operation on a dog; but he could not succeed in insinuating the upper part of the divided bowel into the lower one, on account of the contraction of the two ends of the intestinal tube, and the smallness of the canal. Mœbius was, therefore, obliged to be content with merely bringing the ends of the bowel together with a suture: the animal died, however, of an extravasation of the feces.

Dr. Smith, of the Philadelphia Medical Society, also tried to repeat Ramdohr's method; but could not succeed. He divided the intestine of a dog transversely, and having inserted a piece of candle into that portion of the bowel which was supposed to be uppermost, he endeavoured to introduce the superior within the inferior; but the ends became so inverted, that it was found utterly impossible to succeed. The scheme was, therefore, given up, and only one suture made, the ligature being then attached to the external wound, in the manner advised by Mr. John Bell. The dog died, and on examination there was found a considerable quantity of feces and water in the abdominal cavity.

Two more trials were made of Mr. John Bell's plan by Dr. Smith, on the intestines of dogs: in both instances the animals died, the intestines being much inflamed, and feces effused in the abdomen. See Dr. Smith's Thesis.

Mr. Travers likewise tried the same experiment. "I

divided the small intestine of a dog, which had been for some hours fasting, and carried a fine suture through the everted edges, at the point opposite to their connection with the mesentery. The gut was then allowed to slip back, and the wound was closed. The animal survived only a few hours.—*Examination.* The peritoneum appeared highly inflamed. Adhesions were formed among the neighbouring folds, and lymph was deposited in masses upon the sides of the wounded gut. This presented two large circular orifices. Among the viscera were found a quantity of bilious fluid, and some extraneous substances, and a worm was depending from one of the apertures. By the artificial connection of the edges in a single point of their circumference, and their natural connection at the mesentery, they could recede only in the intervals, and here they had receded to the utmost." In another experiment, Mr. Travers increased the number of points of contact, by placing three single sutures upon a divided intestine, cutting away the threads, and returning the gut. The animal died on the second day.—*Examination.* Similar marks of inflammation presented themselves. The omentum was partially wrapped about the wound; but one of the spaces between the sutures was uncovered, and from this the intestinal fluids had escaped. On cautiously raising the adhering omentum, the remaining sutures came into view. Here again the retraction was considerable, and the intervening elliptical aperture proportionally large. On the side next to the peritoneum, however, the edges were in contact, and adhered, so as to unite the sections at an angle.

From such experiments, the conclusion drawn by Mr. Travers is, that apposition at a point or points is, as respects effusion, more disadvantageous than no apposition at all; for it admits of retraction, and prevents contraction, so that each suture becomes the extremity of an aperture, the area of which is determined by the distance of the sutures. (P. 116. 119.) This gentleman, therefore, maintains, that the absolute contact of the everted surfaces of a divided intestine, in their entire circumference, is requisite to secure the animal from the danger of abdominal effusion. (P. 121.) The species of suture employed, says Mr. Travers, is of secondary importance, if it secures this contact. (P. 134.) And, among other observations, we find, "wounds amounting to a direct division of the canal are irreparable, and, therefore, invariably fatal." P. 133.

In the Dictionary of Practical Surgery will be found several reasons for not entirely agreeing with these conclusions. We cannot admit that a total division of the intestinal tube is certainly and invariably fatal, because we must then not only disbelieve the mode of union in Ramdohr's case, which we undoubtedly do, but we must also disbelieve the result of that case, and of some others which we would cite, were this a publication expressly allotted to surgery. Nor are we at all convinced of the utility of applying numerous sutures to a divided bowel, in order to keep the edges of the wound together. Were a case to present itself to us, in which a bowel was protruded, and partly cut through, we should at most apply only a single suture, made with a common sewing-needle, and some fine silk; and even of the safety and utility of a single suture we entertain doubts. If the bowel were completely cut across; we would also attach its ends together merely by one suture of the same kind; and we should do so without feeling at all assured that the practice of a suture would be at all right. We perfectly coincide, however, with Mr. Travers respecting the advantage of cutting off the ends of the ligature, instead of leaving them in the wound, as we believe he is right in regard to the little chance there is of the injured intestine

testine receding far from the wound; and if the ends of the ligature are then of no use in keeping the bowel in this position, they must be objectionable as extraneous substances. *Dict. of Pract. Surgery*, edit. 3. art. *Wounds*.

The following is the process by which, according to Mr. Travers, a divided intestine is healed, when sutures are employed: "It commences with the agglutination of the contiguous mucous surfaces, probably by the exudation of a fluid, similar to that which glues together the sides of a recent flesh wound, when supported in contact. The adhesive inflammation supervenes, and binds down the everted edges of the peritoneal coat, from the whole circumference of which a layer of coagulable lymph is effused, so as to envelope the wounded bowel. The action of the longitudinal fibres being opposed to the artificial connection, the sections mutually recede, as the sutures loosen by the process of ulcerative absorption. During this time, the lymph deposited becomes organized, by which further retraction is prevented, and the original cylinder, with the threads attached to it, is encompassed by the new tunic.

"The gut ulcerates at the points of the ligatures, and these fall into its canal. The fissures left by the ligatures are gradually healed up; but the opposed villous surfaces, so far as my observation goes, neither adhere nor become consolidated by granulation, so that the interstice, making the division internally, is probably never obliterated." *Travers on Injuries of the Intestine*, &c. p. 128.

The celebrated Scarpa published, a few years ago, some highly interesting remarks on the process employed by nature in repairing solutions of continuity in the intestinal canal, especially in cases of hernia with gangrene; and the results of his investigations are also both curious and instructive, in relation to what happens, and what ought to be done, in wounds of the abdomen. (*Sull'ernie Memorie Anatomico-Chirurgiche*, &c. Milano, 1809.) He observes, that the least fatal consequence of a mortification of the bowel is the escape of the excrement through the wound, or *artificial anus*; an afflicting and disgusting infirmity, but one which does not preclude all hope of a radical cure, even though a considerable portion of the intestinal canal may have been destroyed by sphacelus. The recorded examples of such cures are abundant, and yet, says Scarpa, nothing has yet been written which will serve to convey an exact idea of the simple and admirable means which nature employs in accomplishing them. Surgeons generally suppose, that after the detachment of the dead parts, the two orifices of the bowel remain gaping, and acquire adhesions to the margins of the external wound; that afterwards, in proportion as this contracts, they come gradually nearer together, and in the end touch each other so accurately, that the feces are capable of passing directly from the superior into the inferior portion of the gut. But this theory cannot satisfy those who have attentively examined, in some cases of mortified herniæ, the respective situation of the two orifices of the intestine, and their relation to the external wound. In fact, the two ends of the bowel are constantly found lying in a parallel manner by the side of each other: the upper with its orifice open, and directed towards the external wound by the feces which issue from it; the lower, on the contrary, as it gives passage to nothing, always has a tendency to become less capacious, and retracted into the cavity of the abdomen. The contraction of the external wound cannot have the least effect in changing the direction of these two orifices, nor consequently in applying them to each other. Even supposing there were some natural tendency to this approximation, the upper orifice, being wider than in the natural state, and directed outwards,

could never accurately coalesce with the lower one, which is shrunk, and retracted within the belly. The feces then could never pass from one into the other without the effusion of a large part of them outwardly, and an incurable fistula, discharging the intestinal contents, would in every instance be the consequence.

Scarpa had an opportunity of examining the body of a young man, who, in consequence of eating a large quantity of indigestible food, died about ten months after having been operated upon for a congenital hernia, attended with mortification of the protruded bowels, at a period when he had recovered, with the exception of an occasional discharge of a very small quantity of feces from an inconsiderable fistulous opening. He also dissected two other cases. From all these it appears, that the breach in the intestinal canal is not repaired by the orifices of the upper and lower portions of the bowel re-uniting, coalescing, and running as it were into each other; nay, that they meet at a very acute angle, the axis of one not corresponding with that of the other, and they never lie laterally together. On the contrary, Scarpa's investigations satisfactorily prove, that a funnel-shaped membranous canal (what he terms the *imbuto membranoso*), composed of the remains of the hernial sac, constitutes the medium of communication between the upper and lower orifices of the bowel, which, in an early stage of the case, becomes adherent to the peritoneum about the neck of the hernial sac. The base of the funnel-shaped membranous cavity corresponds to the bowel, and its apex tends towards the wound or fistula. It farther appears, that the feces, in order to get from the upper into the lower part of the bowel, have to pass through the funnel-shaped cavity in quite a femicircular track, and that between the orifices of the bowel, directly opposite to the aperture between the cavity of the intestine and that of the funnel-shaped membrane, a considerable projection or jutting angle is formed, which makes a material additional obstacle to the direct passage of the feces, from the upper into the lower portion of the intestinal tube.

Scarpa thus explains the formation of the funnel-shaped membranous cavity, that constitutes the channel of communication betwixt one part of the bowel and the other: "The hernial sac, as every surgeon knows, does not always partake of gangrene with the viscera contained in a hernia: and even when it does slough, since the separation of the dead parts happens on the outside of the abdominal ring, there almost always remains in this situation a portion of the neck of the hernial sac perfectly found. We may say, therefore, that in all cases immediately after the detachment of the mortified intestine, whether it happen within or on the outside of the ring, the two orifices of the gut are enveloped in the neck of the hernial sac, which soon becoming adherent to them by the effect of inflammation, serves for a certain time to direct the feces towards the external wound, and to prevent their effusion in the abdomen. In proportion as the outer wound diminishes, the external portion of the neck of the hernial sac also contracts; but that part which embraces the orifices of the intestine gradually becomes larger, and at length forms a kind of membranous funnel or intermediate cavity, which makes the communication between the two parts of the bowel. This adhesion of the neck of the hernial sac round the two orifices of the gut does not hinder the latter from gradually quitting the ring, and becoming more and more deeply placed in the cavity of the abdomen." Scarpa then cautions surgeons not to fancy from this account, that there is any occasion to pass a ligature through the mesentery for the purpose of fixing it near the ring, even were the gan-
grenous

grous bowel perfectly free and inadherent to the neighbouring parts. The truth is, that the adhesive inflammation, which also commences immediately after the operation, fixes the parts near the wound before they can be drawn away by any retraction of the bowel or mesentery; and in the course of the first 24 hours the two orifices of the divided intestine are constantly enveloped in the remains of the hernial sac. In a case of this kind, where the mortified bowel was not at all adherent to the neck of the hernial sac, Scarpa introduced a ligature through the mesentery in the usual way, and on withdrawing it at the end of 24 hours, and passing his finger to the bottom of the wound, he found the circumference of the two orifices of the bowel every where adherent. When a ligature through the mesentery had not been practised, and no effusion, he also invariably discovered the bowel adherent to the neck of the hernial sac, in every subject who had died soon after the operation for a strangulated hernia, complicated with gangrene, and whom he examined after death. Certainly, he observes, it must be allowed that the orifices of the divided intestine do retract, and become farther from the ring; but they do so very slowly, and always draw along with them the neck of the hernial sac to which they contract early adhesions.

Our limits oblige us to pass over many other interesting observations relative to the causes which facilitate or retard the re-establishment of the continuity of the intestinal canal, and on the necessity of the funnel-shaped membrane as a substitute for the portion of bowel destroyed by gangrene. We shall next notice the comparison of the artificial anus, arising from a mortified hernia, with that which is the result of a penetrating wound of the abdomen, as made by the intelligent Scarpa. "Why," he inquires, "is it so common to see the continuity of the intestinal canal re-established after a mortified inguinal or crural hernia, while the artificial anus is always incurable, when it is formed in consequence of a penetrating wound of the abdomen with protrusion of the intestine, whether a part of the canal be destroyed by gangrene, as in the instance related by Moscati (Mém. de l'Acad. de Chir. t. 8.), or whether it be totally or partially divided by the wounding instrument, as in the examples recorded by Stalpart-Wander Wiel (Obf. Rar. t. ii. obs. 25.), Cabrole (Oper. Med. obs. 13.), Fabricius Hildanus (Centur. i. obs. 74.), &c.?" Scarpa will not even allow as an exception to this remark the case recited in the 2d vol. of the *Œuvres Chir. de Desault*; because he conceives the details are not sufficiently explicit.

In order to resolve this problem, says he, we have only to compare a wound of the belly complicated with protrusion and mortification of the bowel, with a mortified intestinal hernia, and draw a parallel between the circumstances which accompany the two cases, and constitute their chief differences. 1st, In a hernia, the two extremities of the mortified gut are always enveloped in the remains of the hernial sac, which form in front of the two orifices a kind of funnel-shaped canal. There is nothing like this at the extremities of a bowel divided either by a cutting instrument which has penetrated the abdomen, or by mortification, which has complicated a wound of this description. 2dly, In these last instances, the wounded or burst intestine becomes adherent to the edges of the external wound; consequently, it cannot retract into the abdomen, and the feces, which descend out of the upper portion, being as it were on a level with the skin, must necessarily all escape out of the external wound. This is precisely what actually happens, it being known that artificial ani of this kind are always incurable. After a mortified hernia, on the contrary, it is upon the facility with which the bowel becomes situated farther

from the wound, drawing along with it the remains of the hernial sac, that the formation of an intermediate cavity between the two orifices of the gut depends, and which is to make the communication between them. What happens after penetrating wounds of the belly, with injury of the bowels, is also seen in ventral herniæ, which have formed under the cicatrix of a long-cured wound of the abdomen, when such herniæ are unfortunately attacked by mortification. Large, old, umbilical, and ventral herniæ, though furnished with a hernial sac, generally give rise to incurable artificial ani whenever they slough. Scarpa explains the cause of this circumstance, by adverting to the very intimate adhesion which exists in such herniæ between the sac and the aponeuroses and integuments of the abdomen, and which tends to hinder the formation of the funnel-shaped membranous cavity in front of the orifices of the intestine, and which alone can establish a communication between them.

It follows, says Scarpa, from the foregoing and other facts, that the retraction of the neck of the hernial sac, and of the two orifices of the bowel, is essential to the re-establishment of the continuity of the intestinal canal, when a breach has been made in it by mortification. Hence, he thinks, that in future every body will consider the plan of passing a ligature through the mesentery, in order to keep the two ends of the gut near the outer wound, not only as useless, but even as dangerous. The adhesions of the neck of the hernial sac to the intestine, before the occurrence of gangrene, must almost always render the ligature useless. And even when the adhesion does not exist at the period of cutting through the sloughs, Scarpa asserts that the ligature is equally unnecessary. Indeed, says he, immediately after the operation, while nature is effecting the separation of the dead from the living parts, the latter invariably contract, in a very short time, close adhesions to the neck of the hernial sac, either on a level with a ring, or a little within it, and there is no danger of the feces being extravasated in the abdomen. If the latter accident has sometimes happened in subjects who have died of hernia with gangrene in a few days, it has been because the feces could not make their way outward quick enough, and therefore occasioned a bursting of the bowel in the abdomen, within the ring and beyond the extent of the hernial sac. If, in some other cases, the two orifices of the bowel have been found in the dead subject not adherent to the neck of the hernial sac, and the feces extravasated, Scarpa thinks it has happened only after death, when the relaxation of the whole abdomen has let the ends of the bowel quit the neck of the hernial sac, to which it had not yet acquired any adhesions. But he conceives that nothing like this can ever happen in the living body, owing to the alternate action of the diaphragm and abdominal muscles, which compress all the viscera, and tend to propel them outward.

Hippocrates writes, "Si quod intestinorum gracilium discinditur, non coalescit." (Sect. 4. Aphor. 24.) This aphorism, says Scarpa, taken in its true sense, is the expression of an incontestible fact. It is very true, that wounds of the intestinal canal follow in their cicatrization quite a different course from simple wounds of the skin, muscles, or any other parts of the body. Their edges are never observed to become immediately applied to each other, and therefore, strictly speaking, they do not re-unite. Their cure is altogether completed through the medium of the surrounding parts; that is to say, by the adhesions which the intestines contract with the great sac of the peritoneum lining the parietes of the abdomen, or with the productions of this membrane which compose the external covering

covering of the greater part of the viscera. Littre relates, that a lunatic stabbed himself with a knife in eighteen places about the abdomen, eight of which wounds penetrated into this cavity, and evidently injured the bowels. The man, however, recovered in two months; but in another paroxysm of mania he threw himself out of the window, and was killed. On opening his body, all the cicatrices of the intestinal canal were found adherent to some point of the surface of the adjacent viscera or parietes of the abdomen. There was not a single one which seemed to be formed by the direct contact of the edges of the intestinal wound with each other. Acad. Roy. des Sciences de Paris, 1705.

The peritoneum, when irritated by any cause whatsoever, has a singular disposition to inflame round the point of irritation, and to contract adhesions with the parts which are contiguous to it in the same situation. Thus, when one or several convolutions of intestines have been divided by a cutting instrument, or pierced by a ball, they always become united for a certain extent to the surrounding parts, all of which are covered with the peritoneum. (See also Platner's *Instit. Chir.* § 694.) These adhesions, which are the only means employed by nature for blocking up accidental openings in the intestinal canal, are promoted by the pressure which the abdominal muscles and diaphragm alternately make upon the viscera in the actions of inspiration and expiration.

In a subsequent part of his work, Scarpa delivers his own sentiments on the different plans which have been proposed for effecting the re-union of a divided intestine. If, says he, we compare Ramdohr's operation with the simple and effectual processes employed by nature for re-establishing the continuity of the intestinal canal after herniæ with mortification, we are compelled to acknowledge on this point, as well as on many others, that art continues very inferior to nature.

In the first place, says Scarpa, the introduction of one part of the bowel into the other is impracticable in a great many cases of mortified herniæ, in consequence of the adhesions which the sound part of the intestine has contracted with the neck of the hernial sac, during the inflammatory period of the strangulation. Secondly, it is hardly ever possible, without inconvenience, to draw a considerable portion of the intestinal canal out of the belly, for the purpose of introducing, with all the requisite precautions, the upper end of the bowel into the lower. This cannot be done without handling for too long a time, and more or less roughly, the bowel, which is already irritated; which circumstance, together with the pricks of the needle, and the dragging of the stitches, is more than an adequate cause for the production of a fatal inflammation. The danger will be still farther increased, if, according to the experiments of some modern surgeons, the two ends of the bowel are sewed together over a piece of a calf's trachea, or a small hollow cylinder of tallow, or isinglass, a pasteboard tube, &c. Whatever may be the foreign body put within the bowel, it may, by obstructing the course of the feces, bring on violent inflammatory symptoms, and destroy the patient in the most agonizing sufferings.

Scarpa then adverts to the experiments made on dogs by Dr. Thomson of Edinburgh, and Dr. Smith of Philadelphia, which tend to prove that the two extremities of a divided bowel may be united by means of a future, and then returned into the cavity of the belly, without endangering the animal's life. (See also Boyer's experiments on this subject, in the *Mém. de la Société de Médecine de Paris*, tom. i.) It is alleged (says Scarpa), that there is no risk of the ligatures falling into the cavity of the abdomen after

their detachment; but that by one of the operations of nature which cannot be explained, the threads are voided with the feces after the cure. Scarpa notices that the particulars of the way in which these futures were made is not given; and how (says he) have the above gentlemen succeeded in applying the orifices of the divided bowel accurately to each other, which is extremely difficult, especially in dogs? In whatever light the subject is viewed (he observes), "I doubt whether it be possible to re-unite, by means of any future, the extremities of a divided bowel after mortification in hernia, or at least to do it with any probability of success. Such experiments, even when they succeed in the best possible manner, merely prove that certain operations, which would most frequently be useless or fatal on man, may be successfully practised on other animals."

On the contrary (says Scarpa), in the circumstances which have been supposed, nature is daily observed to succeed in re-establishing the continuity of the intestinal canal, by means equally simple and mild. She prepares herself (as it were) for this work before gangrene actually takes place, by forming adhesions between the strangulated bowel and the neck of the hernial sac. After the separation of the mortified parts, she draws back into the abdomen the extremities of the divided bowel, and out of the remains of the hernial sac, she forms a sort of funnel-shaped membrane, which serves at first for directing the feces outwards, and afterwards for transmitting them from the upper orifice of the intestine into the lower, by making them follow a semi-circular track from before backwards. For two or three instances of the complete success of Ramdohr's operation, an almost innumerable multitude of cures effected altogether by the powers of nature could now be cited. Thus, says Scarpa, in the present state of our knowledge, we should congratulate patients who, in these unfortunate circumstances, fall into the hands of surgeons either incapable of undertaking an operation, or little solicitous about healing up the wound.

It may perhaps be imagined (continues Scarpa), that Ramdohr's operation is better calculated for certain cases of penetrating wounds of the abdomen, as, for instance, where the intestine has been completely divided with a cutting instrument, or by the effects of gangrene arising from long exposure to the air. Scarpa here allows that it would be very desirable to find out some operation which could be useful in these circumstances, which are the more unfortunate, because they do not furnish nature with the means of re-establishing the continuity of the intestinal canal, as in cases of mortified herniæ. But he doubts whether in such instances Ramdohr's operation could be undertaken with any probability of success; for the complete division of the intestine is almost always the result of an enormous wound, which having interested several viscera leaves little or no hope of recovery. Supposing the bowel should not have been divided with the cutting instrument, but that it is protruded and gangrenous from long exposure, it must be remembered, that in this case it will have contracted adhesions to the lips of the wound, even before the separation of the mortified part; consequently, the bowel cannot be drawn farther out of the belly, so as to allow one end of it being introduced into the other. To undertake such an operation then, would be to expose the patient to much greater perils than that of an incurable artificial anus.

According to Scarpa, it is little to have proved that Ramdohr's operation is impracticable when the intestine has been completely divided; he proceeds farther, and has no hesitation in asserting, that *in all cases of penetrating wounds*

of the abdomen, attended with injury of the intestine, whether the canal be opened longitudinally or transversely, a future is always an operation not merely useless, but even dangerous and fatal. In whatever manner it is practised, one cannot avoid the evils which must originate from the punctures, however few, and from the passage of the ligatures through the coats of the intestine; a part endued with exquisite sensibility, and whose external tunic is much disposed to inflame, and rapidly to communicate the inflammation to all the other abdominal viscera. It has been unfortunately proved, by the experience of several ages, that in most of the cases in which the intestine has been stitched in penetrating wounds of the belly, the patients have died in the greatest agony. If a few have escaped the dangers of this operation, it has been because in them the stitches soon cut their way out, and were voided with the feces which continued to escape from the wound until it was entirely healed.

All surgeons of experience, and particularly those of large hospitals, have often seen wounds of the right or left iliac region accompanied with injury of the great intestine. They may also have noticed, in these examples, that after the subsidence of the local and general inflammatory symptoms, the wound still continues to discharge the feces for a certain time; but that afterwards it contracts, and the excrement resumes its usual course. These wounds almost always heal completely: first, because the adhesion of the large intestine to the parietes of the abdomen prevents the feces from being extravasated in the cavity of the peritoneum; and secondly, because the ample capacity of the same bowel always presents a ready passage for the feces, notwithstanding the progressive and sometimes quick closure of the external opening.

If, in the instance of a penetrating wound of the belly attended with a wound of the small intestines, it were in the surgeon's power (as indeed it is) to return the bowel into the abdomen, so that the opening in it may exactly correspond with the wound in the abdominal parietes, there could not be a doubt of its quickly acquiring adhesions to the peritoneum, which lines the part around the internal orifice of the external wound: hence the feces would readily escape through the outer wound, and at length it would happen, after a certain time, as in wounds of the large intestines, that the artificial anus would gradually close up, and the feces resume their natural track. The narrow diameter of the small intestines would not make an insurmountable obstacle to the passage of the feces, provided they be, as they usually are in this portion of the intestinal canal, sufficiently fluid; and besides (says Scarpa) is it not proved by experience, that they resume their natural course, after the cure of an artificial anus, even when a considerable noose of the small intestines has been destroyed by gangrene, and when the two ends form by their re-union a very acute angle? In all cases, the patient's life would be saved, and the worst that could happen would be his being afflicted the rest of his days with a fistula discharging feces.

Encouraged by these principles, which are the natural deductions of a comparison of wounds of the large intestines with those of the small ones, Scarpa feels no hesitation in admitting the possibility of curing the latter, without having recourse to a future. He observes, that it would not be difficult for him to quote examples of such cures. Amongst others, he has lately seen one which deserves to be mentioned here. A portion of small intestine, protruded through a penetrating wound of the abdomen, happened to be punctured with a bodkin by a country surgeon, in his endeavours to return the part into the belly. The feces, however, were not extravasated in the cavity of the peri-

toneum, but were for a long while discharged through the wound. The opening in the bowel always corresponded exactly to that in the parietes of the abdomen, although no future was practised, nor any ligature put through the mesentery in order to keep it in this situation. The feces afterwards gradually resumed their natural course, the wound at the same time became smaller, and in the end healed up. The young man, the subject of this case, now enjoys very good health, and suffers no inconvenience which can justify a suspicion of any obstruction in the passage of the feces.

The incessant pressure made by the abdominal muscles and diaphragm upon all the viscera, is a cause why the wounded intestine, instead of quitting the external wound, enters it, and contracts adhesions to its lips. If, however, a too timorous surgeon were afraid of entirely trusting, on this point, to the wise providence of nature, he might (Scarpa thinks) without inconvenience pass a ligature through the mesentery, behind the portion of wounded bowel, as is usually and quite unnecessarily done in cases of mortified hernia. Forty-eight hours, or thereabouts, would be time enough for the intestine to contract adhesions, through the medium of the peritoneum, to the inner edges of the wound. After this period, the ligature would be completely useless, and it ought to be withdrawn, as there would now be no chance of extravasation of the feces in the belly. At the same time one should neglect no remedies, internal as well as external, which may be of use in moderating the patient's sufferings, diminishing the energy of the circulation, and bringing the inflammation down to the degree requisite for the formation of adhesions. One ought also to keep open the external wound with the same precautions, and according to the same indications which are to be attended to in the treatment of an artificial anus. The principal object of these precautions is, to let the treatment be such that the wound may only diminish in proportion as the evacuation from the lower part of the intestinal canal increases.

Here it may be *à propos* to observe, that the conduct of a surgeon in the treatment of penetrating wounds of the abdomen, attended with injury of the small intestines, is exactly the reverse of what it ought to be in the treatment of penetrating wounds of the chest, accompanied with injury of the lungs.

In the latter, says Scarpa, physiology, agreeing with experience, teaches us that no means should be omitted for effecting the immediate union of the wound, (as it is termed, *by the first intention*;) care being taken to check the force of the circulation by repeated bleedings and every antiphlogistic remedy, in order to prevent or diminish, as much as possible, internal hemorrhage. If, notwithstanding all these means, blood should be extravasated between the pleura and lungs, it presses equally upon every point of these viscera, resists their motion, and thereby contributes to stop the bleeding. If, after the wound in the lungs is healed, the extravasated blood be not in too large quantity, it will be gradually removed by the absorbents. In the contrary case, it will form a swelling beneath the external cicatrix, and present itself externally (see Discours sur les Principales Maladies observées à l'Hôtel Dieu de Lyon, &c. par M. Petit, p. 299.); or else a counter opening must be practised at the inferior part of the chest. See ΕΜΠΥΕΜΑ.

We are to act quite differently in the treatment of a penetrating wound of the belly, with protrusion and injury of the intestine; for in this case, the chief indication, that on which the patient's safety mainly depends, consists in keeping the external wound open, in order that the feces may find a ready outlet. The wounded bowel soon contracts

adhesions to the inner lips of the wound of the belly, and then we have nothing to fear from an extravasation of the intestinal matter in the cavity of the peritoneum. Afterwards, in proportion as the feces resume their natural course, the external wound is to be allowed to diminish, and entirely heal up. See Scarpa Sull'ernie Memorie Anatomico-Chirurgiche, &c. mem. 4.

In every instance in which the abdomen has received a penetrating wound, attended with injury and protrusion of a portion of the intestinal canal, the displaced part is to be reduced, whether it be stitched or not. This should be accomplished as speedily as possible, before the bowel has suffered much from exposure, constriction, &c. and also before any adhesions have formed at the inner orifice of the external wound; adhesions which would render the reduction of the protruded part impracticable. Of course, if the wound should be too small to admit of the reduction being effected without handling and bruising the bowel immoderately, it ought to be carefully enlarged with a curved bistoury, guided on a director. Indeed, according to Scarpa's principles, one would suppose that in every case of this kind the wound, if not free, should be dilated, as by this means the issue externally of whatever escapes from the breach in the intestine after its reduction would be facilitated. The rest of the treatment consists in the rigorous adoption of antiphlogistic measures, more especially a low diet, and copious and repeated venesections, with a view of counteracting the danger of peritoneal inflammation. With respect to the dressings, they cannot be too simple, and they ought always to be light and superficial. A pledget of any common unirritating ointment is all that is requisite, and it must be renewed as frequently as the quantity of the discharge, &c. from the wound may render necessary.

3. *Penetrating Wounds of the Belly, attended with Injury of the Bowels, but with no Protrusion.*—A wound of the intestines is indicated by the discharge of blood with the stools, and sometimes by the escape of fetid air, or of intestinal matter from the external wound. Such an injury, however, when the wounded bowels lie concealed in the belly, does not always admit of being known with certainty immediately after occurrence. In the majority of examples, there is at first no escape either of air, or of the contents of the bowels, from the external wound; the quantity of blood voided per anum may be inconsiderable, and of course none at all will generally be discharged for some time after the accident. Wounds of the small intestines, especially of the duodenum and jejunum, are indeed usually followed by great anxiety, paleness of the countenance, syncope, cold perspirations, a small intermitting tremulous pulse; but then these symptoms are only equivocal, and furnish no positive information, because several of them may happen in nervous subjects, from a mere superficial unimportant cut or stab. Our inability, however, to say assuredly, in every case, whether the bowels are injured or not, is a thing of no practical importance; because when the nature of the accident is not clearly manifested by some peculiarity or severity of the symptoms, the case should invariably be treated on common, simple, antiphlogistic principles; and also, when circumstances leave not the smallest doubt of the intestines being hurt, the same treatment is the only rational one which can be pursued. Wounds of the small intestines are reckoned much more dangerous than those of the large; and the nearer the injury is to the pylorus, the greater, generally speaking, is the degree of danger. Such cases are also much more frequently, than injuries of the large intestines, the cause of extravasation. In the latter examples, the symptoms are commonly milder, and either the passage

of the intestinal contents outward through the wound more easy and certain, on account of the bowel being naturally less moveable than the other intestines; or their passage in their natural course more ready, by reason of the greater capacity of that part of the intestinal tube.

A wounded intestine is said to present some particular appearances, to which the generality of writers have paid no attention. "If a gut be punctured, the elasticity of the peritoneum, and the contraction of the muscular fibres, open the wound; and the villous or mucous coat forms a sort of hernial protrusion, and obliterates the aperture. If an incised wound be made, the edges are drawn asunder and reverted, so that the mucous coat is elevated in the form of a fleshy lip. If the section be transverse, the lip is broad and bulbous, and acquires tumefaction and redness from the contraction of the circular fibres behind it, which produces, relatively to the everted portion, the appearance of a cervix. If the incision is according to the length of the cylinder, the lip is narrow, and the contraction of the adjacent longitudinal, resisting that of the circular fibres, gives the orifice an oval form. This eversion and contraction are produced by that series of motions, which constitutes the peristaltic action of the intestines." Travers on Injuries of the Intestines, p. 85.

According to this gentleman, some of these appearances were described by Haller, in *Element. Physiol. lib. 24. sect. 2.* and *Opera Minora, tom. i. sect. 15.*

Having witnessed the facility with which considerable injuries of the intestinal tube were repaired, Mr. Travers was desirous of ascertaining more fully the powers of nature in the process of spontaneous reparation, and of determining under how great a degree of injury it would commence, as well as the mode of its accomplishment. For these purposes, he divided the small intestine of several dogs as far as the mesentery. All these animals died, in consequence of the intestinal matter being extravasated, if they had been lately fed, or if they had been fasting in consequence of inflammation, attended with a separation of the ends of the divided bowel, eversion of the mucous coat, and obliteration of the cavity, partly by this eversion, and partly by a plug of coagulated chyle.

In one particular instance in which Mr. Travers made a division of the bowel half through its diameter, a sort of pouch was formed round the injured intestine. "A pouch, resembling somewhat the diverticulum in these animals, was formed opposite to the external wound, on the side of the parietes, by the lining peritoneum; on the other side, by the mesentery of the injured intestine, that intestine itself, and an adjacent fold, which had contracted with it a close adhesion. The pouch, thus formed and insulated, included the opposed sections of the gut, and had received its contents, &c. The tube at the orifices was narrowed by the half eversion, but offered no impediment to the passage of fluids." (P. 96.) Whether, under these circumstances, the functions of the alimentary canal could have been continued, Mr. Travers professes himself incapable of deciding. Among the inferences which this gentleman has drawn from the experiments detailed in his publication, the tendency of the two portions of a divided bowel to recede from each other, instead of coalescing to repair the injury, merits notice, inasmuch as it tends to shew that the only means of spontaneous reparation consist in the formation of an adventitious canal, by the encircling bowels and their appendages. The everted mucous coat, which is the part opposed to the surrounding peritoneum, is also indisposed to the adhesive inflammation.

When, however, the wound of the intestine is smaller,

the obstacles to reparation are not absolutely insurmountable. Here retraction is prevented, and the processes of eversion and contraction modified by the limited extent of the injury. If, therefore, the adhesive inflammation unite the contiguous surfaces, effusion will be prevented, and the animal escape immediate destruction. But union can only take place through the medium of the surrounding parts.

According to Mr. Travers, it is the retraction immediately following the wound that is a chief obstacle to the reparation of the injury; for if the division be performed in such a way as to prevent retraction, the canal will be restored in so short a time, as but slightly to interrupt the digestive function. In confirmation of this statement, a ligature was tightly applied round the duodenum of a dog, which became ill, but entirely recovered, and was killed. "A ligature, fastened around the intestine, divides the interior coats of the gut, in this effect resembling the operation of a ligature upon an artery. The peritoneal tunic alone maintains its integrity. The inflammation, which the ligature induces on either side of it, is terminated by the deposition of a coat of lymph, which is exterior to the ligature, and quickly becomes organized. When the ligature, thus enclosed, is liberated by the ulcerative process, it falls of necessity into the canal, and passes off with its contents." P. 103, 104.

It appears also from Mr. Travers's experiments and observations, that longitudinal wounds of the bowels are more easily repaired than such as are transverse. In a dog, a longitudinal wound, of the extent of an inch and a half, was repaired by the adhesive inflammation. Here the process of eversion is very limited; the aperture bears a smaller proportion to the cylinder of the bowel; and the entire longitudinal fibres resist the action of the circular, which are divided, and can now only slightly lessen the area of the canal. P. 108.

When the wounded bowel lies within the cavity of the abdomen, no surgeon of the present day would have the rashness to think of attempting to expose the injured intestine, for the purpose of sewing up the breach of continuity in it. In fact, the surgeon seldom knows at first what has happened; and when the nature of the case is afterwards manifested, by the discharge of blood per anum, an extravasation of intestinal matter, &c. it would be impossible to get at the injured part of the bowel, not only because its exact situation is unknown, but more particularly on account of the adhesions, which are always formed with surprising rapidity. But even if the surgeon knew to a certainty, in the first instance, that one of the bowels was wounded, and the precise situation of the injury, no future could be applied, without considerably enlarging the external wound, drawing the wounded intestine out of the cavity of the abdomen, and handling and disturbing all the adjacent viscera. Nothing would be more likely than such proceedings to render the accident, which might originally be curable, unavoidably fatal. We must agree upon this point with Mr. John Bell, who says, "When there is a wounded intestine, which we are warned of only by the passing out of the feces, we must not pretend to search for it, nor put in our finger, nor expect to sew it to the wound; but we may trust that the universal pressure, which prevents great effusion of blood, and collects the blood into one place, that very pressure, which always causes the wounded bowel and no other to protrude, will make the two wounds, the outward wound and the inward wound of the intestine, oppose each other point to point; and if all be kept there quiet, though but for one day, so lively is the tendency to inflame, that the adhesion will be begun, which is to save the patient's life." Discourses on Wounds, p. 361. edit. 3.

When the extravasation and other symptoms, a few days after the accident, evince the nature of the case, a future can be of no use whatever, as the adhesive inflammation has already fixed the part in its situation, and the space, in which the extravasation lies, is completely separated from the general cavity of the abdomen by the surrounding adhesions.

When the bowel is not protruded, and the opening in it is situated closely behind the wound in the peritoneum, a suture is not requisite; for the contents of the gut, not passing onward, will be discharged from the outer wound, and not be diffused among the viscera, if care be taken to keep the external wound open. There is no danger of the wounded bowel changing its situation, and becoming distant from the wound in the peritoneum; for the situation which it now occupies is its natural one. Nothing but violent motion, or exertions, could cause so unfavourable an occurrence, and these should always be avoided. The adhesions, which take place in the course of a day or two, at length render it impossible for the bowel to shift its situation. See Dict. of Pract. Surgery, edit. 3. art. *Wounds*.

In a penetrating wound of the abdomen, as a late author remarks, whether by gun-shot, or a cutting instrument, if no protrusion of intestine takes place, (and this, it must be observed, in musket or pistol wounds, rarely occurs,) the lancet, with its powerful concomitants, abstinence and rest, particularly in the supine posture, are our chief dependence. Great pain and tension, which usually accompany these wounds, must be relieved by leeches, if they can be procured, by the topical application of fomentations, and the warm bath; and if any internal medicine is given as a purgative, it must, for obvious reasons, be of the mildest nature. The removal of the ingesta, as a source of irritation, is best effected by frequently repeated oleaginous glysters; indeed, on the first infliction of a wound of the abdomen, the contents of the intestinal canal and stomach are generally evacuated spontaneously, the stools being sometimes tinged with blood. Their accumulation must be guarded against by a rigorous diet; for to the general state of fulness of the vessels induced by food, is added its local and mechanical stimulus in the undigested form. By this treatment, penetrating wounds, in which several plicæ of intestines have been necessarily implicated, have been happily cured. Authors abound with instances of this kind, and Mr. Hennen has seen several: among others, he was witness to the recovery of a soldier, who had been shot through the abdomen with a ramrod, at the siege of Badajos in 1812, which passed in anteriorly, and actually stuck in the vertebræ, from which it was not disengaged without the application of some force. Garengot and Lamotte also record cures, after the passage of swords completely through the body. See Hennen's Obs. on Military Surgery, p. 436, 437.

In all penetrating wounds of the belly, the dressings cannot be too simple and light.

In some instances, the ball, or part of the weapon which has inflicted the wound, remains within the abdominal cavity, and is afterwards evacuated by the natural passages.

Balls, says Mr. Hennen, frequently pass clean through the abdomen, evidently wounding the intestines, but without occasioning any protrusion of them at either of the orifices. These cases, like all others of those parts, are extremely dangerous, but are not necessarily mortal. They require the most guarded attention, and the utmost watchfulness of the approach of inflammation, which often comes on most insidiously. The mildest possible application should be employed to the wounds, and no plugging with tents

or introduction of medicated dressings thought of. (P. 440.) At first a common linseed poultice, and afterwards simple pledgets, are as eligible dressings as any which can be mentioned.

Extravasation in the Abdomen.—Wounds of the abdomen may be complicated with extravasations of blood, chyle, excrement, bile, or urine. None of these complications, however, are half so frequent as an unreflecting and inexperienced practitioner might apprehend. The employment of the phrase *cavity of the abdomen* has paved the way to much erroneous supposition upon this subject, and has induced many absurd notions, which even the sensible observations long ago published by Petit (le fils) have scarcely yet dispelled.

As a modern writer has observed, "there is not truly any cavity in the human body, but all the hollow bowels are filled with their contents, all the cavities filled with their hollow bowels, and the whole is equally and fairly pressed. Thus, in the abdomen all the viscera are moved by the diaphragm and the abdominal muscles, upwards and downwards, with an equable continual pressure, which has no interval; and one would be apt to add, the intestines have no repose, being kept thus in continual motion; but though the action of the diaphragm, and the re-action of the abdominal muscles, are alternate, the pressure is continual; the motion which it produces (they produce) is like that which the bowels have when we move forwards in walking, having a motion with respect to space, but none with regard to each other, or to the part of the belly which covers them; the whole mass of the bowels is alternately pressed, to use a coarse illustration, as if betwixt two broad boards, which keep each turn or intestine in its right place, while the whole mass is regularly moved. When the bowels are forced down by the diaphragm, the abdominal muscles recede: when the bowels are pushed back again, it is the re-action of the abdominal muscles that forces them back and follows them; there is never an instant of interruption of this pressure, never a moment in which the bowels do not press against the peritoneum; nor is there the smallest reason to doubt that the same points in each are continually opposed. We see that the intestines do not move, or at least do not need to move in performing their functions; for in hernia, where large turns of intestines are cut off by gangrene, the remaining part of the same intestines is closely fixed to the groin, and yet the bowels are easy, and their functions regular. We find the bowels regular when they lie out of the belly in hernia, as when a certain turn of intestine lies in the scrotum, or thigh, or in a hernia of the navel; and where yet they are so absolutely fixed, that the piece of intestine is marked by the straightness of the rings. We find a person, after a wound of the intestine, having free stools for many days; and what is it that prevents the feces from escaping, but merely this regular and universal pressure? We find a person on the fourth or fifth day with feces coming from the wound! a proof, surely, that the wound of the intestine is still opposite, or nearly opposite, to the external wound. We find the same patient recovering without one bad sign! What better proof than this could we desire, that none of the feces have exuded into the abdomen?"

"If in a wound of the stomach the food could get easily out by that wound, the stomach would unload itself that way, there would be no vomiting, the patient must die; but so regular and continual is this pressure, that the instant a man is wounded in the stomach he vomits, he continues vomiting for many days, while not one particle escapes into the cavity of the abdomen. The outward wound is commonly opposite to that of the stomach, and by that

passage some part of the food comes out; but when any accident removes the inward wound of the stomach from the outward wound, the abdominal muscles press upon the stomach, and follow it so closely, that if there be not a mere laceration extremely wide, this pressure closes the hole, keeps the food in, enables the patient to vomit, and not a particle, even of jellies or soups, is ever lost, or goes out into the cavity of the belly.

"How (proceeds Mr. J. Bell), without this universal and continual pressure, could the viscera be supported? Could its ligaments, as we call them, support the weight of the liver? Or, what could support the weight of the stomach when filled? Could the mesentery or omentum support the intestines; or could its own ligaments, as we still name them, support the womb? How, without this uniform pressure, could these viscera fail to give way and burst? How could the circulation of the abdomen go on? How could the liver and spleen, so turgid as they are with blood, fail to burst? Or, what possibly could support the loose veins and arteries of the abdomen, since many of them, e. g. the splenic vein, is (are) two feet in length, is (are) of the diameter of the thumb, and has (have) no other than the common pellucid and delicate coats of the veins? How could the viscera of the abdomen bear shocks and falls, if not supported by the universal pressure of surrounding parts? In short, the accident of hernia being forced out by any blow upon the belly, or by any sudden strain, explains to us how perfectly full the abdomen is, and how ill it is able to bear any pressure, even from its own muscles, without some point yielding, and some one of its bowels being thrown out. And the sickness and faintness, which immediately follow the drawing off of the waters of a dropsy, explain to us what are the consequences of such pressure being even for a moment relaxed. But perhaps one of the strongest proofs is this, that the principle must be acknowledged, in order to explain what happens daily in wounds; for though in theory we should be inclined to make this distinction, that the hernia, or abscess of the intestines, will adhere and be safe, but that wounded intestines, not having time to adhere, will become flaccid, as we see them do in dissections, and so, falling away from the external wound, will pour out their feces into the abdomen, and prove fatal; though we should settle this as a fair and good distinction in theory, we find that it will never answer in practice. Soldiers recover daily from the most desperate wounds; and the most likely reasons that we can assign for it are, the fulness of the abdomen, the universal, equable, and gentle pressure, and the active disposition of the peritoneum ready to inflame with the slightest touch. The wounded intestine is, by the universal pressure, kept close to the external wound, and the peritoneum and the intestine are equally inclined to adhere. In a few hours that adhesion is begun which is to save the patient's life, and the lips of the wounded intestine are glued to the lips of the external wound. Thus is the side of the intestine united to the inner surface of the abdomen; and though the gut casts out its feces while the wound is open, though it often casts them out more freely while the first inflammation lasts, yet the feces resume their regular course whenever the wound is disposed to close." John Bell's Discourses on Wounds, p. 323—327, edit. 3.

The foregoing extract, though drawn up in the most careless style, contains such observations as are well calculated to make the reader understand that the abdomen is in reality not a cavity, but a compact mass of containing and contained parts; that the close manner in which the various surfaces are constantly in contact must powerfully oppose extravasations; and that in fact it often entirely prevents them.

them. The passage cited impresses us with the utility of that quick propensity to the adhesive inflammation which prevails throughout every peritoneal surface, and which not only often has the effect of permanently hindering effusion of the contents of the viscera, by agglutinating the parts together, but which, even when an extravasation has happened, beneficially confines the effused fluid in one mass, and surrounds it with such adhesions of the parts to each other as are rapid in their formation, and effectual for the purposes of limiting the extent of the effusion, and preventing the irritation of the extravasated matter from affecting the rest of the abdomen.

It is to M. Petit that we are indebted for the introduction of more correct modes of thinking upon the foregoing subject. See *Mém. de l'Acad. de Chirurgie*.

But notwithstanding the influence of the reciprocal pressure of the containing and contained parts against each other, and the useful effect of the quickly arising adhesive inflammation in all penetrating wounds of the belly, complicated with the injuries of the viscera, we are not to suppose that extravasation never happens, but only that it is much less frequent than has been commonly supposed. Mr. Travers, with much laudable industry, has endeavoured to trace more minutely than any preceding writer the particular circumstances under which effusions in the abdomen are likely or unlikely to happen. "It being admitted (says he) that there are cases in which effusion does take place, it is easy to conceive circumstances which must considerably influence this event. If, for example, the stomach and bowels be in a state of emptiness, the nausea which follows the injury will maintain that state. If the extent of the wound be considerable, the matter will more readily pass through the wound than along the canal. A wound of the same dimensions in the small and the large intestines will more readily evacuate the former than the latter, because it bears a larger proportion to the calibre. Incised and punctured wounds admit of the adhesion of the cut edges, or the eversion of the internal coat of the gut, so as to be in many instances actually obliterated; whereas lacerated or ulcerated openings do not admit of these salutary processes. Again, in a transverse section of the bowel, contraction of the circular fibre closes the wound, whereas in a longitudinal section, the contraction of this fibre enlarges it. Such (says Mr. Travers) are the circumstances which, combined in a greater or less degree, increase or diminish the tendency to effusion." On *Injuries of Intestines*, &c. p. 13, 14.

After the details of some experiments and cases, the preceding author makes among other conclusions the following:

1. That effusion is not an ordinary consequence of penetrating wounds.
2. That if the gut be full, and the wound extensive, the surrounding pressure is overcome by the natural action of the bowel tending to the expulsion of its contents.
3. That if food has not recently been taken, and the wound amounts to a division of the gut, or nearly so, the eversion and contraction of the orifice of the tube prevent effusion.
4. That if the canal be empty at the time of the wound, no subsequent state of the bowel will cause effusion, because the supervening inflammation agglutinates the surrounding surfaces, and forms a circumscribed sac; nor can effusion take place from a bowel at the moment full, provided it retains a certain portion of its cylinder entire, the wound not amounting nearly to a semi-division of the tube, for then the

eversion and contraction are too partial to prevent an extravasation.

5. That when, however, air has escaped from the bowel, or blood has been extravasated in quantity within the abdomen at the time of the injury, the resistance opposed to effusion will be less effectual, although the parietal pressure is the same, as such fluids will yield more readily than the solids naturally in contact. P. 25, 26. 100.

6. That though extravasation is not common in penetrating wounds, it follows more generally in cases where the bowel is ruptured by blows, or falls upon the belly, while the integuments continue unwounded. P. 36.

7. That when the bowels are perforated by ulceration, there is more tendency to effusion than in cases of wounds. P. 38, &c.

Mr. Travers explains the reason of the greater tendency to effusion, in cases of intestines burst by violence, and in those of ulceration, "by the difference in the nature of the injury which the bowel sustains when perforated by a sword or bullet, as in the one case, or burst or ulcerated in the other. A rupture by concussion could only take place under a distended state of the bowel, a condition most favourable to effusion, and from the texture of the part, a rupture so produced would seldom be of limited extent. The process of ulceration, by which an aperture is formed, commences in the *internal* coat of the bowel, which has always incurred a more extensive lesion than the peritoneal covering. The puncture or cut is merely a solution of continuity in a point or line; the ulcerated wound is an actual loss of substance. The consequence of this difference is, that while the former, if small, is glued up by the effusion from the cut vessels, or, if large, is nearly obliterated by the full eversion of the villous coat, the latter is a permanent orifice." P. 46.

Blood is more frequently extravasated in the abdomen than any other fluid. Extravasations of this kind, however, do not invariably happen, whenever vessels of not a very considerable size are wounded. The compact state of the abdominal viscera, in regard to each other, and their action on each other, oppose this effect. The action alluded to, which depends on the abdominal muscles and diaphragm, is rendered very manifest by what happens in consequence of operations for herniæ attended with alteration of the intestines, or omentum. If these viscera should burst or suppurate after being reduced, the matter which escapes from them, or the pus which they secrete, is not lost in the abdomen, but is propelled towards the wound of the skin, and there makes its exit. The intestinal matter effused from a mortified bowel has been known to remain lodged the whole interval between one time of dressing the wound and another, in consequence of the surgeon stopping up the external wound with a large tent. When the above-mentioned action or pressure of the muscles is not sufficient to keep the blood from making its escape from the vessels, still it may hinder it from becoming diffused among the convolutions of the viscera, and thus the extravasation is confined in one mass. The blood, effused and accumulated in this way, is commonly lodged at the inferior and anterior part of the abdomen, above the lateral part of the pubes, and by the side of one of the recti muscles. The weight of the blood may propel it into this situation, or perhaps there may be less resistance in this direction than in another. In opening the bodies of persons who have died with such extravasations, things may put on a different aspect, and the blood seem to be promiscuously extravasated over every part of the abdomen. But when such bodies are examined with care, it will be found that

the blood does not insinuate itself among the viscera till the moment when the abdomen is opened, and the mass previously lies in a kind of pouch. This pouch is frequently circumscribed, and bounded by thick membranes, especially when the extravasation has been of some standing. Sabatier, *Médecine Opératoire*, tom. i. p. 28—30.

It is of the highest consequence to a practical surgeon to remember well that all the parts contained in the abdomen are closely in contact with each other, and with the inner surface of the peritoneum. This is one grand reason why extravasations are seldom so extensively diffused as one might imagine, but commonly lie in one mass, as Petit, Sabatier, and all the best moderns, have noticed. The pressure of the elastic bowels, of the diaphragm, and abdominal muscles, not only frequently presents an obstacle to the diffusion of extravasated matter, but often serves to propel it towards the mouth of the wound. The records of surgery make mention of numerous instances in which persons have been stabbed through the body without any fatal consequences, and sometimes without the symptoms being even severe. In Mr. Travers's publication many cases exemplifying this observation are quoted from a variety of sources. Fab. Hildan. *Obs. Chirurg.* cent. v. obs. 74. *Œuvres de Paré*, liv. x. chap. 35. *Wife's Surgery*, p. 371. *La Motte's Traité Complet de Chirurgie*, &c. &c. In such cases, the bowels have been supposed to have eluded the point of the weapon, and this may, perhaps in a few instances, have been actually the fact; but in almost all such examples there can be no doubt that the bowels have been punctured, and an extravasation of intestinal matter has been prevented by the opposite pressure of the adjacent viscera. Such resistance and pressure may also have occasionally obliged intestinal matter, or blood actually extravasated, to pass through the wound of the bowel into its cavity, and thus be speedily removed. Certain it is, such copious evacuations of blood *per anum* have followed stabs of the abdomen as could hardly proceed from the arteries of the intestines. This way of getting rid of an extravasation must be rare, however, compared with that by absorption.

The pouch or cyst including extravasated blood or matter, as mentioned by Sabatier, is formed by the same process which circumscribes the matter of abscesses. (See SUPPURATION.) It is in short the adhesive inflammation. All these surfaces in contact with each other, and surrounding the extravasation and track of the wound, generally soon become so intimately connected together by the adhesive inflammation, that the place in which the extravasation is lodged is a cavity entirely destitute of all communication with the cavity of the peritoneum. The track of the wound leads to the seat of the effused fluid, but has no distinct opening into the general cavity of the abdomen. The rapidity with which the above adhesions form is often very great, almost incredible.

Urine and bile are more frequently dispersed to a great extent among the abdominal viscera than blood. The latter fluid, indeed, must often coagulate; a circumstance that must both tend to stop further hemorrhage, and confine the extravasation in one mass.

Symptoms and Treatment of Extravasations in the Abdomen.

—1. *Blood.*—Wounds of the spleen, and of such veins and arteries as are above a certain size, almost always prove fatal from internal hemorrhage. The blood generally makes its way downwards, and accumulates at the inferior part of the abdomen, unless the existence of adhesions happen to oppose the descent of the fluid to the most depending situation. The belly swells, and the fluctuation of a fluid is per-

ceptible through the anterior part of the abdominal parietes. The patient grows pale, loses his strength, is affected with syncope, and his pulse becomes weaker and weaker. In short, the symptoms usually attendant on hemorrhage are observable. The viscera and vessels in the abdomen being continually compressed on all sides by the surrounding parts, the blood cannot be effused without overcoming a certain degree of resistance; and unless a vessel of the first magnitude, like the aorta, the vena cava, or one of their principal branches, has been wounded, the blood escapes from the vessel slowly, and several days elapse before any considerable quantity has accumulated in the lesser cavity of the pelvis.

In these cases of extravasated blood, the symptoms, which perhaps had disappeared under the employment of bleeding and anodyne medicines, now come on again. A soft fluctuating tumour may be felt at the lower part of the abdomen, sometimes on the right side, sometimes on the left, occasionally on both sides. The pressure made by the effused blood on the urinary bladder excites distressing inclinations to make water; while the pressure which the sigmoid flexure of the colon suffers is the cause of obstinate constipation. In the mean time, the quantity of extravasated blood increasing, irritation and inflammation of the peritoneum are induced. The pulse grows weaker, debility ensues, the countenance is moistened with cold perspirations; and, unless mitigated by all the antecedent circumstances, the surgeon practises an incision for the discharge of the fluid, the patient falls a victim to the accident.

In the year 1733, Vacher, principal surgeon of the military hospital at Besançon, successfully adopted this mode of treatment. Petit (the son) afterwards tried the same plan, though it did not answer, (as is alleged,) in consequence of the inflammation having advanced too far before the operation was performed. Long before the time of Vacher and Petit, a successful instance of similar practice had been recorded by Cabrol.

Indeed, when the symptoms leave no doubt of there being a large quantity of blood extravasated in the abdomen; when the patient's complaints are of a very serious nature, and are evidently owing to the irritation and pressure of the blood on the surrounding viscera; and when a local swelling denotes the seat of the extravasation, there cannot be two opinions about the propriety of making an incision for its evacuation.

Surgeons, however, should recollect, that a small extravasation of blood may exist without producing any considerable irritation, provided no opening be made into the cyst with which it becomes surrounded. On the contrary, when such cyst is opened, the air then having free access to the blood contained there, that part of the fluid which cannot be discharged is apt to putrefy, and become so irritating, as to excite inflammation of the surrounding parts.—Even though there may be an evident extravasation of blood, the bad symptoms are also sometimes entirely owing to the injury done to the parts within the abdomen, and neither to the pressure nor the irritation of the effused blood.

But sometimes, as we have already noticed, the accumulated blood at first neither irritates the adjacent parts by its quantity nor quality. An inflammation, however, of the parts surrounding the extravasation at length takes place. The tension, irritation, and pain, which in the first instance arose from the wound itself, and subsided, seem now to be renewed. When the extravasation is at the lower and anterior part of the abdomen, the patient experiences pain about the hypogastric region. He is also constipated, and as he suffers

suffers great irritation of the bladder, he feels frequent propensities to make water, but cannot relieve himself. At last a tumour makes its appearance, attended with a fluctuation more or less distinct.

In this instance, it seems proper to give vent to the accumulated blood. If this fluid should be found coagulated, injections of warm water would facilitate its discharge. Sabatier, *Médecine Opératoire*, tom. i.

2. *Chyle and Feces*.—These are not so easily extravasated in the abdomen as blood, because they do not require so much resistance on the outside of the stomach and intestines, to make them continue their natural route through the alimentary canal, as blood requires to keep it in the vessels. Extravasations of this kind, however, sometimes happen when the wound is large and the bowel distended at the moment of the injury, or when, as Mr. Travers has likewise explained, air is extravasated, or blood effused in the abdomen; these fluids being incapable of making effectual resistance to the escape of the intestinal matter. (See an Inquiry into the Process of Nature in repairing Injuries of the Intestines, &c. p. 26.) Nothing is a better proof of the difficulty with which chyle and feces are extravasated than the operation of an emetic, when the stomach is wounded and full of aliment. In this instance, if the resistance to the extravasation of the contents of the stomach were not considerable, they would be effused in the abdomen, instead of being vomited up. A peculiarity in wounds of the stomach and intestines is, that the opening which allows their contents to escape may also allow them to return into the wounded viscus.

Extravasation of intestinal matter in the abdomen is attended with a severe train of febrile symptoms; dryness of the mouth, tongue, and fauces; considerable pain and swelling of the belly; convulsive startings; and hiccough and vomiting, with which the patients are generally attacked on the day after that on which the wound was received. Sabatier de la *Médecine Opératoire*, tom. i. p. 34.

In these cases, general means are the only ones which can be employed; venesection, fomentations, low diet, perfect rest, anodynes, &c. All solid food must be most strictly prohibited. The close state of the viscera may also be increased by applying a bandage round the body.

If the symptoms are not speedily alluaged, the abdominal viscera become affected with general inflammation and gangrene, and the patients die in the course of a few days.

3. *Bile*.—Bile, on account of its great fluidity, is more easily extravasated extensively in the abdomen than either blood or the contents of the stomach and intestines. Besides, the gall-bladder has the power of contracting itself so completely as to expel the whole of its contents. Notwithstanding these circumstances, however, extravasations of this kind are exceedingly uncommon, doubtless on account of the small size of the gall-bladder, and its deep-guarded situation, between the concave surface of the liver and upper part of the transverse arch of the colon.

Sabatier informs us, that he has only been able to find one example on record. This case, after having been communicated to the Royal Society of London by Dr. Steward (N^o 414, p. 341. Abridgm. tom. vii. p. 571, 572.), was inserted as an extract in the third volume of the *Edinburgh Essays*, and also in the third volume of Van Swieten's *Commentaries on the Aphorisms of Boerhaave*. (Transl. p. 65. edit. 1754.) An officer received a wound, penetrating the cavity of the abdomen, and entering the fundus of the gall-bladder, without doing any material injury to the adjacent parts. The abdomen was immediately distended, as if the patient had been afflicted with an ascites, or tympanitis;

nor did the swelling either increase or diminish till the patient's death, which happened a week after the infliction of the wound.

There was no rumbling noise in the abdomen, though it was exceedingly tense. There were no stools, and very little urine was discharged, notwithstanding purgatives and glysters, and a good deal of liquid nourishment, were given. The patient never had one instant of sound sleep, but was always restless, though anodynes were exhibited. There was no appearance of fever, and the pulse was always natural till the last day of the patient's life, when it became intermittent. The intestines were found, after death, very much distended, the gall-bladder quite empty, and a large quantity of bile extravasated in the abdomen.

Sabatier met with an opportunity of observing the symptoms of an extravasation of bile, in consequence of a wound of the gall-bladder. The patient's abdomen swelled very quickly; his respiration became difficult, and he soon afterwards complained of tension, and pain in the right hypochondrium. His pulse was small, frequent, and contracted; his extremities were cold, and his countenance very pale. The bleedings which were practised the first day gave him a little relief; but the tension of the abdomen, and the difficulty of breathing, still continued. A third bleeding threw the patient into the lowest state of weakness, and he vomited up a greenish matter. On the third day, the lower part of the belly was observed to be more prominent, and there was no doubt of an extravasation. M. Sabatier introduced a trocar, and gave vent to a green blackish fluid, which had no smell, and was pure bile, that had escaped from the wound of the gall-bladder. After the operation, the patient grew weaker and weaker, and died in a few hours. On opening the body, a large quantity of yellow bile was found between the peritoneum and intestines; but it had not insinuated itself among the convolutions of the viscera. A thick gluten connected the bowels together, and they were prodigiously distended. The gall-bladder was shrivelled, and almost empty. Towards its fundus, there was a wound about a line and a half long, corresponding to a similar wound in the peritoneum. The wound which had occurred at the middle and lower part of the right hypochondrium, between the third and fourth false ribs, had glided from behind forward, and from above downward, between the cartilages of the ribs, until it reached the fundus of the gall-bladder.

Sabatier takes notice, that the symptoms of the two cases which have just now been related were very similar. Both the patients were affected with an exceedingly tense swelling of the belly, unattended with pain or borborygmus, and they were both obstinately constipated. Their pulse was extremely weak the latter days of their indisposition, and they were afflicted with hiccough, nausea, and vomiting.

M. Sabatier seems to think one thing certain, *viz.* that wounds of the gall-bladder, attended with effusion of bile, are absolutely mortal, and that no operation can be of any avail. *Médecine Opératoire*, tom. i. p. 34—37.

We are, however, to infer the contrary from the extraordinary case lately published by Mr. Fryer of Stamford. A boy, about thirteen years old, received a violent blow from one of the shafts of a cart, on the region of the liver. The injury was succeeded by pain, frequent vomiting of bilious matter, great sinking, coldness of the extremities, and a weak, small, fluttering pulse. The belly was fomented, and purging clysters thrown up. On the third day, symptoms of inflammation began, attended with considerable pain about the liver, great tension and foreness of
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the abdomen, and frequent vomiting. The pulse was quick, small, and weak, the skin hot and dry, the tongue much furred, the urine high coloured; and there was some difficulty of breathing, and great thirst. Eight ounces of blood were taken away, the fomentations continued, and a few grains of calomel were directed to be given every four hours, until the bowels were properly opened. Afterwards the effervescing mixture, with ten drops of laudanum, was exhibited every four hours.

On the following day, the patient had had some motions, and was much better; but as his sickness continued, he was ordered a grain of opium every four hours. About a week afterwards, he complained of a great increase of pain, which was somewhat relieved by a blister. He was now completely jaundiced, and his stools were white, but the tension, pain, and sickness, were abated.

Two days afterwards, a fluctuation was perceived in the abdomen, which in another week became considerably distended with fluid. The patient now did not complain of much pain, but appeared to be sinking fast; a puncture was made in the swelling, and thirteen pints of what appeared to be pure bile were evacuated. The bowels then soon became regular, and the appetite good. In twelve days, the operation was repeated, and fifteen pints of the same bilious fluid were drawn off. Nine days afterwards, another puncture was made, and thirteen pints more let out; and six were discharged in another fortnight. From this period the boy went on well, and perfectly recovered under the use of light tonic medicines. See *Medico-Chirurgical Transactions*, vol. iv. p. 330.

A previous accidental adhesion of the gall-bladder to the peritoneum might also certainly prevent the extravasation of bile, and its dangerous effects. Callisen, *Syst. Chir. Hoediernæ*, tom. i. p. 718.

Mr. Hennen has never known a patient recover after a wound of the gall-bladder; and indeed, says he, it is difficult to imagine a case where the injury could happen without an effusion of bile into the abdominal cavity, except a previous adhesion had taken place to the parietes. A case, however, is mentioned in the "*Opusculæ de Chir.*" of M. Paroisse, where a leaden ball had lodged in the gall-bladder two years.

4. *Urine*.—Urine being of a very fluid nature may, like the bile, be easily extravasated in the abdomen, when the bladder is wounded at any part which is connected with the peritoneum. If the urine in this kind of case be not drawn off with a catheter, so as to prevent it from issuing by the wound of the bladder, the patient soon perishes. There are many instances recorded of the bladder being injured even by gun-shot wounds which were not mortal. (See Larrey's *Mém. de Chir. Mil.* especially tom. iv.) Such wounds, however, might only have injured the sides or lower part of the bladder. But in operating for the stone above the pubes, the bladder has undoubtedly been occasionally cut at the part of the fundus which is covered with the peritoneum. However, as the accident was known in the first instance, the right treatment was adopted, and such patients have recovered. Sabatier, *Médecine Opératoire*, tom. i. p. 37.

Wounds of the bladder are particularly characterized by a discharge of bloody urine and difficulty of making water. They must always be regarded as dangerous cases, both on account of the risk of the effusion of so irritating a fluid in the abdomen, and of the chance of extravasation in the cellular membrane. Under proper treatment, however, they often admit of cure. The effused fluid should, if possible, be discharged by a depending posture, or suitable punctures or incisions, and its recurrence prevented by the introduction

of a catheter, which is to be left in the urethra. The patient must also be allowed little drink. As for the tension and pain of the belly, the perpetual attendants of a wounded bladder, they may be greatly relieved by the use of the warm bath. (Callisen, tom. i. p. 719.) Bleeding and other antiphlogistic means are not to be omitted. See *Dict. of Pract. Surg.* art. *Wounds*.

Extraneous bodies, particularly balls, as Mr. Hennen observes, are frequently carried into the bladder itself, either as it rises above the pubes or through the openings in the pelvis, or work their way into it, and either come off by the natural passage, or are removed by a surgical operation resembling lithotomy. Wounds of the bladder, he remarks, are dangerous in proportion as it is full of urine at the time of their receipt, or as the upper and anterior, or lower and posterior part of the viscus may be wounded. If the intestines are implicated in the wound, it is highly dangerous. Inflammation from wounds of these parts runs rapidly into gangrene, which is chiefly brought on by the effusion of urine in the cellular membrane. "If there is a free extensive passage, much of this danger will be obviated; and after the first effusion from the bladder has taken place, the judicious use of the elastic gum catheter affords us an admirable assistance against this accident." "Indeed," says Mr. Hennen, "without this useful instrument, our practice in wounds of this nature, and in those affecting the urethra, would be merely confined to looking on and moderating symptoms, instead of preventing them." (P. 460.) The rest of the treatment consists in letting out, without delay, the effused urine by proper incisions, and employing the antiphlogistic plan, in the full sense of the expression, together with mild superficial dressings or poultices, and the utmost attention to cleanliness.

A deep wound of the liver, Mr. Hennen considers as fatal as one of the heart itself. Slighter injuries of this organ, he sets down as sometimes recovering. He says, that the usual symptoms which characterize wounds of the liver are, yellowness of the skin and urine, derangement of the stomach and of the alimentary canal, and cutaneous affections, particularly great and distressing itching. The discharge from the wound is generally yellow and glutinous; but he has seen it of a ferous nature, and sometimes very nearly allied to unmixed bile.

Wounds of the liver, says another writer, may cause a large effusion of blood from the outer wound, or in the abdomen, a cadaverous yellow countenance, pain in the shoulder, slow pulse, dulness of the eyes, great anxiety, cold sweats, and finally death, which happens the more quickly and certainly, the greater the wound is, and the nearer it is situated to the place where the large vessels enter this organ. But small wounds of the liver, particularly of its convex surface, when it is adherent to the peritoneum, admit of cure. Callisen, tom. i. p. 718.

The treatment is to be at first conducted entirely on antiphlogistic principles, venesection, and mild aperient medicines in particular being employed. Afterwards small doses of the pil. hydrarg. and tonic medicines will tend to re-establish the health.

A wound of the stomach may be known by the discharge of aliment from the external opening; by the vomiting of blood; the pain, the anxiety, and other symptoms of violent nervous irritation. Large wounds of this organ, especially those about the cardiac orifice, or great curvature, or such as extend through both sides of the viscus, are for the most part fatal in a few days: but when the wound is differently situated, and properly treated, it may often be cured. In certain instances, however, a fistula remains, through which

a part of the food sometimes escapes. Two cases of wounds of the stomach are recorded by Dr. Thomson, in his *Obs. on the Military Hospitals in Belgium*. One was from a musket-ball; the other from a pike. They were treated on the mild, unirritating plan, adapted for wounds of the intestines, and both ended well. "The histories of the Bohemian, Prussian, and English 'cultrivores,' from some of whom the knives have been cut out, and from others discharged spontaneously, through the coats of the stomach and parietes of the abdomen; as well as many other instances on record, are (as Mr. Hennen observes) very encouraging in cases of injuries of this organ." M. Hevin, in the *Mém. de l'Acad. de Chir. tom. i. p. 144.* has collected a number of interesting instances of recovery, both from incised and gun-shot wounds. But (says Mr. Hennen) the industrious Plouquet, in the articles "Ventriculus" and "Pantophagi," has exceeded all others for the vast number of cases he has amassed. In our own *Philosophical Transf., Lowthorpe's Abridgment, vol. vi. p. 192.* or in the modern one, by Drs. Hutton, Shaw, and Pearson, *vol. iv. p. 66.* an instance is given, where the stomach of a horse was wounded and sewed up, and a similar instance in the human species: both recovered. More recently sutures have been applied to its wounds in Holland and France, as may be seen in the "*Annales de Litterature,*" &c. by Kluyfskens, *vol. 2.* and in the "*Traumalogia*" of Schlichting, &c. Notwithstanding these narratives, however, we have no doubt of the rashness of such practice, and all that can be said about it is, that the patients had to overcome both the injury and the bad treatment of it. Not unfrequently a wound of the stomach has become fistulous. Richerand gives a very curious case of this kind, where the opening remained for nine years; Etmuller, in the 5th vol. of Haller's "*Disputationes Chirurgicæ,*" gives an instance, where it continued open for ten years; and Wenker, in the same volume, relates a case where a wound of the stomach continued open twenty-seven years. (See Hennen on Military Surgery, p. 481, &c.) Copious bleeding, abstinence, and rest, are the best remedies in the early stage of all such cases.

Wounds of the spleen mostly prove fatal by the profuse hemorrhage arising from them. Mr. Hennen, however, assures us, that he has seen some slight wounds of this viscus terminate favourably. It has sometimes been cut out of brutes, without any fatal or even any bad consequences; and there is a recent instance recorded, in which it protruded from an incised wound, the surgeon removed it, and the patient got well. (See *Medico-Chirurg. Journal, vol. i. 1816.*) It has also been tied and cut out in some other instances with success. See cases in Gooch's *Chir. Works, vol. i. p. 97;* Leveillé's *Doctr. Chir. tom. i. p. 400;* also some references in Thomæ Bartholini *Anatome, p. 158. 8vo. Lugd. Bat. 1686, &c.*

Wounds of the spleen have scarcely any symptom which is peculiar to them. According to Celsus, however, there is great pain in the shoulder, as in wounds of the liver. The loose structure of the spleen, and the magnitude of its vessels, must always render its injuries highly dangerous.

Wounds of the pancreas, according to Callisen, are not characterized by any peculiar symptom, except the effusion of a fluid analogous to the saliva. The pancreas, like the duodenum, can hardly be wounded, without the weapon having at the same time injured other viscera. (*Syst. Chir. Hodiernæ, tom. i. p. 719.*) Gooch sets down wounds of the pancreas as mortal, if its duct or blood-vessels be injured. *Chir. Works, vol. i. p. 99.*

Wounds of the kidneys and ureters are always dangerous, on account of the hemorrhage and effusion of urine. When

the latter fluid insinuates itself within the peritoneum, or into the cellular membrane, the patient has but a very discouraging chance of preservation. Small wounds of the kidney, however, may be cured, though a fistula will sometimes remain. The danger of wounds of the kidney is well pointed out in M. Hevin's *Essay on Nephrotomy, in the Mém. de l'Acad. de Chir.,* and a great mass of evidence is produced on the subject. The recoveries which Mr. Hennen has seen, after wounds of the kidneys, he observes, are very few indeed. "If the patient has survived the first hemorrhage, the fever and peritoneal inflammation, with incessant hiccough and vomiting from sympathy of the diaphragm and stomach, have generally cut him off; and if he has for a time escaped, excruciating pains, profuse suppuration from fistulous fores, hectic, and emaciation, have terminated his existence. Where the cure has been effected, there is reason to think that the ureter has been but slightly brushed, and the body of the kidney itself left untouched. The remedies consist in venesection, mild purgatives, as manna, oil, &c. frequent emollient enemata, the warm bath generally, and local fomentations, &c. with a diet of the mildest kind, but much restricted in fluids, the indulgence in which, even in small quantity, should be avoided." The same author properly condemns all stimulants, blisters, and diuretics; and he recommends light dressings, so as to allow the urine to escape freely. The integuments near the wound he also advises to be greased, so as to prevent the irritation of the urine from making them inflame and ulcerate. See *Obs. on Military Surgery, p. 454.*

The subject of wounds is one of infinite length, and this must apologize for the extent of the present article, in which a great deal is still omitted. Had we introduced a full account of the wounds of every part of the body, our observations would have formed a production more than twice as long as that which we have now finished; but we thought that so minute and elaborate a paper would hardly be desirable in a work not expressly allotted to the consideration of surgery.

WOUNDS in Horses. The most terrible wounds these creatures are subject to are those got in the field of battle. The farriers that attend camps have a coarse way of curing these; but it is a very expeditious and effectual one. If the bullet be within reach, they take it out with a pair of forceps; but if it lie too deep to be come at, they leave it behind, and dress up the wound in the same manner as if it were not there.

They first drop in some varnish from the end of a feather, and when the bottom is thus wetted with it, they dip a pledget of tow in the same varnish, which they put into the wound, and then cover the whole with the following charge: Take a quarter of a pound of powder of bole armenic, half a pound of linseed-oil, and three eggs, shells and all; add to these four ounces of bean-flour, a quart of vinegar, and five ounces of turpentine; this is all to be mixed over the fire, and the wound covered with it. This application is to be continued four or five days, then the tent put into the wound is to be dipped in a mixture of turpentine and hog's-lard; by this means a laudable matter will be discharged, instead of the thin sharp water that was at first. Then the cure is to be completed by dressing it with an ointment made of turpentine, first well washed, and then dissolved in yolks of eggs, and a little saffron added to it.

This is the practice in deep wounds that do not go through the part; but in cases where the bullet has gone quite through, they take a few weavers' linen thrumbs, made very knotty; these they make up into a kind of link, and dipping it in varnish, they draw it through the wound,

leaving the ends hanging out at each side; by means of these they move the link or skein three or four times a day, always wetting the new part that is to be drawn into the wound with fresh varnish. They put on a charge of the bole armenic, &c. as before described, on each side of the wounded part, and continue this as long as the wound discharges thin watery matter, or the sides continue swelled. After this they dress it with the ointment of the turpentine, yolks of eggs, and saffron, till it is perfectly cured.

The other methods are, the dressing of the wound with an ointment made of wax, turpentine, and lard, and covering it with linen rags wetted with cream; or the dressing with a mixture of yolks of eggs, honey, and saffron, and covering it up with cream and baum-leaves beaten together.

When the wound is so dangerous as to require the assistance of internal medicines, they give the following pills: Take assafœtida, bay-berries, and native cinnabar, of each a pound; beat up the whole into a mass with brandy, and roll it into pills of fourteen drachms each. These are to be laid in a shady place to dry, after which they will keep ever so long without any damage. The horse is to take two of these every other day, or, if necessary, every day, till he has taken eight or ten of them, and he is to stand bridled two hours before and after the taking of them.

When the wound seems at a stand, not appearing foul, and yet not gathering new flesh, there must be recourse had to the following powder, whose effect in bringing new flesh is wonderful: Take dragon's blood, and bole armenic, of each two ounces; mastic olibanum, and sarcocolla, of each three drachms; aloes, round birth-wort, and common iris-root, of each one drachm and a half; make the whole into a fine powder. This is sometimes used dry, sprinkling it on the wound; but sometimes it is mixed with turpentine, sometimes with juice of wormwood, and sometimes with honey of roses, and either way does very well.

When the wound grows foul, and requires a detergent to cleanse it, the common liquor for this purpose is a plagedenic water, which they make of lime-water, and sublimate in this manner: Take two pounds and a half of newly-made and unslaked lime, put it into a pewter vessel, and pour on it five quarts of boiling water. When the bubbling is over, let it stand to rest two or three days, stirring it often with a stick; then pour it clear off after due time for the lime to settle, and filtre it through some whited-brown paper, made for the lining of funnels, on this occasion. To a quart of the clear lime-water, thus prepared, add eight ounces of spirit of wine, and one ounce of spirit of vitriol; when these are well mixed, by shaking them together, then add an ounce of corrosive sublimate in fine powder: mix all well together, and keep the whole in a bottle, to be used for the cleansing of these foul wounds, and on any other occasions, where a detergent of this powerful kind may be necessary. It will keep good many years.

If this water will not thoroughly cleanse the wound, but there still will remain a quantity of foul matter in it, and there is danger of a gangrene, they add to it as much arsenic in fine powder as there was of the corrosive sublimate; that is, at the rate of an ounce to a quart and half a pint.

These are all the medicines which the farrier need carry with him on account of wounds; and they are all such as may be prepared at home, and will continue good so long as he has occasion to keep them, or much longer; and what is left of one year will serve for others.

When the necessary applications are thus settled, it may not be improper to add the general rules by which they conduct themselves in the cure.

1. The wound must be probed at first, but very gently,

and afterwards as gently and as seldom as may be, for the horse's flesh is the most easy of all others to be contused in wounded parts, and to fall into a gangrene from the hurt. 2. The wound must be kept continually as clean as possible, and free from proud flesh. 3. The necessary revulsion must always be made by bleeding, as soon as the wound is dressed the first time; this prevents inflammation, and a great many other bad accidents. 4. If the wound be in such a place that the horse can get at it with its tongue to lick it, great care must be taken to prevent his doing so, as it will greatly retard the cure. 5. The farrier never is to proceed to suppuration in any case in which the humours can be either dissolved or repelled, and especially in parts that are full of sinews and ligaments, or that are near the bones. 6. If a wound be accompanied with a great contusion, or if it be of a round or circular figure, incisions are often necessary about its edges, and sometimes the application of caustics. 7. The wound must be always carefully covered, for the access of the air retards the cure. 8. The callous lips of a wound must always be cut to the quick, before they can be united together. These may serve for general rules, that hold good in all cases: and to these may be added some that are principally applicable to peculiar circumstances of the wounds.

Wounds of the breast are to be cured with tents and folds of soft linen laid over them, steeped in the following mixture: Take verdigrise, vitriol, and alum, of each one ounce; vinegar, eight ounces; honey, a pound; let all these be boiled together till they become red.

Wounds in the belly can only be cured by sewing up the peritoneum with strong woollen thread, not silk, leaving the extremities without the skin. The skin is to be sewed together with strong hempen thread waxed, joining the lips of the wound together, by this means, in form of a buckle. This is to be covered with the common ointment for wounds; and if an inflammation comes on, chalk dissolved in vinegar is to be added.

If the wound be such that the guts come out at it, the horse may still be recovered, if proper caution be used: the guts are to be immediately returned into their place; but they must not in this be touched with the hand, but with a sponge dipped in warm water. And, in order to the making them more readily get into their places, it is proper to make the creature vomit, by thrusting down his throat a feather dipped in oil. If the wound through which they fell is not big enough to return them easily by, it must be enlarged by cutting; but if the guts are found to be bruised or wounded, it is in vain to attempt any thing, for death must follow.

There is also a certainty of death when, after a wound of any kind in the belly, the horse voids blood at the fundament.

When a horse is wounded near the groin, he easily falls into convulsions; in this case, he is to be kept from drinking as much as possible: he is also to be covered well up, and kept quiet, and to have green things given him to eat.

Wounds on the knees are very difficult to cure, because the part is in motion almost continually, and there is very little flesh to work upon. When the wounds are but slight, and in the muscular parts of the body, a mixture of honey and tallow, boiled together, will often prove a cure; when the wound is more considerable, turpentine melted in a little common oil, and applied hot, is the general remedy.

If a wound happens between the shoe and the hoof, care must be taken that no foreign matter be left in it, and it must be dressed with any of the ointments that have verdigrise in them; and a charge of bruised elder-leaves is very proper

proper to be applied over all. If the wound be deep and narrow, it must be enlarged at the orifice, and turpentine and wax, melted in lard, must be poured into it. The same rule of opening the orifice holds good in all deep and narrow wounds.

If a nerve happens to be cut, it must be closed, and a defenative must be applied, to prevent a concourse of humours to the part; a fomentation made of oil, wine, and honey, mixed together, is also very proper, wherever a nerve is hurt, and a poultice may be applied over all, made of marshmallow-roots boiled soft, with bread and milk.

If the horse happens to be wounded by a piece of wood, bone, or any other hard substance, part of which remains in the wound, this must be carefully taken out, whatever pain it may cost the creature to do it, and the wound must then be dressed with the common wound-ointments. In this, or any other case of a fresh wound, the washing it with oil of turpentine is an excellent method of preventing ill consequences.

WOUNDS in Trees, such as are caused in lopping and pruning their branches, or otherwise. Mr. Nichol, in his "Practical Planter," has shewn, that lopping of strong branches becomes not necessary, and that all wounding in pruning should be performed on or towards the extremities of boughs which have inferior laterals to partake of and divert their luxuriance of growth from injuring the stem or leader. It is also shewn, that from this mode little ill is to be apprehended, and consequently that the treatment of such wounds is simple, and which is so much the better for the plant and the interest of its owner. Such wounds require no other attention than being lopped clean off with a sharp knife or bill; and, if the saw is used, being afterwards smoothed with the knife. And it were to be wished, for the sake of much timber, which otherwise might have been rendered more valuable, that wounds of another description had been unnecessary, or had never been inflicted. The writer here alludes to the necessity of lopping by the bole all stumps, &c. occasioned by formerly-injudicious pruning, and the wanton folly of those who lop large branches by or near to the stem, when simply shortening them at a proper distance would answer a better purpose. But since it becomes necessary to clear formerly-injured trees of stumps, &c. in order to prevent farther decay, it also becomes a duty to follow the most rational and simple mode of treatment. With this view, it is briefly observed, that whenever it becomes necessary to lop a stump by the bole, or to shorten any branch larger than the wrist or ankle; in the former case, the wound should be to the quick, that is, to the level of the bark, on the stem at least; and in the latter, *obliquely* across the branch, so as, from its position, to prevent moisture from lodging: being careful to prevent laceration, by notching the bark underneath, before the amputated part falls down, or to one side. In both cases, the face of the wound and edges of the bark are to be made perfectly smooth with the knife; and in a few hours after, or so soon as they are quite dry, let the wound be carefully plastered with tar, (such as is used for sheep-smearing,) or laid over with white or blue lead, which has been well mixed up with oil, and rendered rather thicker than is commonly used for painting. The tar is, however, certainly preferable, being of a more healing nature; and if laid on in a thin state, it is not so apt to scale off by the action of the weather as the paint. This operation should be performed in the *fall* of the year; at which time, the wound is not so apt to crack, and likewise dries sooner than at any other season. If, however, in the course of the

ensuing summer, or at any subsequent period, the tar or paint is found to rend or scale off, care must be taken to renew and keep the platter sound and smooth, until the bark grow over and cover the wound; and this should be more particularly observed in respect of wounds on the trunk.

In the case of *polling* a tree, lopping an upright branch, or in training for ship-timber, stopping the leader, &c. when, from the upright position of the wounded part in question, plastering or painting, as above, might be deemed insufficient to prevent water from penetrating, and of consequence injuring the wood at the part affected; yet by this treatment, infection, or the farther decay of the rest of the tree, will be prevented. But there are some who ridicule the idea of using plaster of any kind, urging for argument that the bark grows as fast together of itself without this aid, and why bury in the heart of the tree a load of rubbish? But they certainly have not considered, that a decayed part of the vegetable being buried in its heart, cannot possibly again be renovated, or become sound timber; but, on the contrary, must operate to the corruption of the rest. And this question, why bury in the tree a load of rubbish? leads, it is said, to a decision in favour of using tar, since, besides that the body inclosed is quite thin, it is of a genial, healing nature, acts as a cement to the fracture, and afterwards becomes equally sound as the wood.

And this may be demonstrated by examining fir-trees which have been wantonly hacked *deeply*, had holes bored into them for fastening gates to, which have afterwards been removed, and above all in the operation of extracting rosin; in all which cases, the wound is closed up by the resinous juice of the tree, and generally becomes perfectly sound as the rest of the wood, although a blemish may be the consequence. Wherefore, with respect to resinous trees, nature prevents the necessity of our interference in the cure of wounds, other than the fracture of limbs; which it is certainly our duty to amputate, in order to prevent farther decay and unsightly appearance; but she will hastily cover the wound with the plaster superior to any we can prepare.

WOUND-Wort, in *Botany*, the name given to several figures belonging to different genera.

WOUND-Wort of Achilles. See **ACHILLEA**.

WOUND-Wort, Clown's, a species of *Stachys*. See **STACHYS**.

WOUND-Wort, Hercules's, or *All-heal*, the *laserpitium chironium* of Linnæus. This is a native of the warmer climates, and bears the colds of our own. Both the seeds and roots of this species are considerably warmer than those of the *garden* and *wild* parsnep. The roots and stalks have a strong smell and taste, resembling those of opoponax: and Boerhaave relates, that on wounding the plant in summer, he obtained a yellow juice, which, being inspissated a little in the sun, agreed perfectly, in both respects, with that exotic gum-resin. Lewis. See **LASERPITUM**.

WOUND-Wort, Saracen's, Solidago. See **SOLIDAGO**.

WOUND-Wort, True Saracen's, a species of *Senecio*. See **SENECIO**.

WOUNICS, in *Geography*, a town of Austrian Poland; 32 miles E.S.E. of Cracow.

WOUTERS, FRANCIS, in *Biography*, was born at Liere, in Brabant, in 1614. He was a student in the school of Rubens, but applied himself principally to landscape, and became one of the most eminent of his time. He chose for his models the scenes of his native country, and particularly the forest of Soignes, near Brussels; embellishing the views he chose with groups of figures representing historical or allegorical

allegorical subjects. Sometimes he attempted history, but not successfully. He was in favour with the emperor Ferdinand II.; but coming to England with his ambassador in 1637, he was appointed chief painter to the prince of Wales, afterwards Charles II. On the breaking out of the rebellion he returned to Antwerp, and became director of the academy there, where in 1659 he was killed by the accidental discharge of a gun.

WOUVERMANS, PHILIP, was a remarkable and melancholy instance of those mis-fapen and unhappy combinations of talent, industry, and ill-fortune, which have occasionally disgraced the world of connoisseurship. He was the son of an indifferent historical painter, and was born at Haerlem in 1620. Having obtained possession of his father's store of pictorial knowledge, he was placed with John Wynants, the landscape-painter, under whose instruction he soon acquired a considerable degree of power in embodying the creations of his own fancy, and to this acquisition he added much by an attentive study of nature.

There is but little known of his private life. Celebrity, which now attends his name, formed no part of his enjoyments; indeed they appear to have been few, and confined to his affection for and attention to his art and his family, which was numerous. His pictures, beautiful as they are, agreeable in their composition and colour, and exquisite in their finish, exhausted his time without raising him above indigence and obscurity. The more free, slight, and loose works of Peter de Laer, called Bamboccio, absorbed the admiration of the Dutch collectors, while the elegant and delightful productions of Wouvermans remained unnoticed and unknown. Time has adjusted the balance, and the united voice of the tasteful now sheds a lustre over the name of the latter; too late, alas! for his gratification or benefit.

The neglect which he endured, and the severity of labour required to complete so many pictures as he has left, in so high and perfect a degree of finishing, exhausted his health, and he died at the early age of 48; having burnt a short time before his death all his studies and drawings, to prevent, as he declared, his children from being induced to follow a profession which had been but a source of poverty and misery to himself.

The subjects of his pictures are drawn from the common scenes of nature, but are sometimes of a more elevated cast than those chosen by the generality of his compatriots, particularly his hawkings and huntings, where cavaliers and high dames, with appropriate scenery, rich trappings to their horses, and numerous retinues, are introduced with great taste and propriety. His encampments and battles are composed with the same skill and suavity; indeed the latter is a principal characteristic of all his works, whatever be their subjects, from the humble hay-cart to the richest combination of materials which the gay palace, its garden, and splendid adornments, afforded him. Farriers' shops, fairs of horses, travellers on their road, or at inn-doors, &c. &c. were equally rendered agreeable by his delightful arrangements of chiaro-oscuro and of colours, and by the exquisitely firm full touch with which they are executed. His works are numerous, and when in good preservation sell at very considerable prices.

WOUVERMANS, PETER, the younger brother of Philip, was also an artist of considerable talent, though by no means equal to him. He was also born at Haerlem, about the year 1625. He was trained under R. Rogman, but principally followed his brother's style, and adopted his class of subjects. But though his pictures are frequently sold for Philip's, yet they are not so delicate or spirited, and may be easily distinguished from his by a cultivated eye. There

was also another brother, a few years younger than Peter, who followed the same line of art with rather more talent; so that we cannot be surprised at the number of pictures which bear the name of Wouvermans. John died in 1666, at the age of 38.

WOXEN, in *Geography*, a large and noisy current of Sweden, formed by the discharge of the lake of Saima into the Ladoga, which forms a vast cataract about a mile from its mouth.

WOXNA, a town of Sweden, in Helplingland; 40 miles W. of Soderhamn.

WOXTORP, a town of Sweden, in the province of Smaland; 27 miles N.W. of Wexio.

WOYE, a town of Germany, in the principality of Culmbach; 5 miles S.E. of Hof.

WOYTZ, a town of Silesia, in the principality of Neisse; 2 miles E. of Ottmucha.

WRA, a town of Sweden, in the province of Smaland; 48 miles W.S.W. of Wexio.

WRACK. See WRECK.

WRACK, in *Natural History*. See WRECK.

WRACK, in *Agriculture*, a name sometimes given to a marine plant, which is of great utility as a manure. With this plant surgeons sometimes make a cataplasm, by bruising a quantity of it, and applying it in cases of scrofula, or white-swelling, but more particularly glandular tumours. Where this cannot be got, sea-water and oat-meal formed into a poultice have supplied its place. There is no reason why the tumours and ill-conditioned sores of brute animals should not be benefited by similar applications. See WRECK.

It is frequently termed *sea-wrack*, *sea-tangle*, and *sea-oak*. See *SEA-Weed*.

WRAGBY, in *Geography*, a small market-town in the wapentake of Wingrove, Lindsey division of the county of Lincoln, England, is situated at the junction of the turnpike-roads leading from Lincoln to Louth and Horncastle, and is distant 11 miles N.E. by E. from Lincoln, and 144 miles N. by W. from London. George Villiers, duke of Buckingham, who possessed this manor in the reign of Charles II., obtained from that monarch a charter to hold a weekly market on Thursday and two annual fairs, which are now well frequented. Sir Edmund Turnor, who purchased the manor of the duke, erected and endowed an alms-house for six clergymen's widows, and six other destitute persons, for whose use he built a chapel, with an augmentation to the vicarage of 40*l. per annum* for prayers to be read in it twice every day: this chapel was consecrated by bishop Gardiner July 18, 1697. Here is also a free-school, founded and endowed in 1633 by William Hanford, esq. The population of Wragby is stated, in the return of the year 1811, to be 709; the number of houses 103. The manor is now possessed by Edmund Turnor, esq. who has a seat in the adjacent parish of Panton, called Panton-hall, which was built by Hawkmoor, a pupil of sir John Vanbrugh, in the year 1724: considerable additions have been made to it from the designs of Mr. Carr, architect at York; and the adjoining country has been greatly improved by ornamental plantations. Two miles north of Wragby is Halton Lodge, the seat of colonel Caldicot, in whose family the manor of Halton has been vested for several generations.—*Beauties of England and Wales*, vol. ix. Lincolnshire; by J. Britton, F.S.A. 1808.

WRAIN-BOLTS, in *Ship-Building*, are iron ring-bolts, used when planking ships, &c. with two or more fore-lock holes near the end, for taken-in the set, as the plank, &c. works nearer the timbers.

WRAIN-Staves, a sort of stout billets of tough wood, tapered

tapered at the ends so as to go into the ring of the wrain-bolt, to make the sets necessary for bringing-to the planks or thick stuff to the timbers.

WRAM, in *Geography*, a town of Sweden, in the province of Skone; 13 miles W.S.W. of Christianstadt.

WRANGLER, SENIOR, a technical term in the university of Cambridge, for the student who passes the best examination in the senate-house, and confers lasting reputation. They who follow next in the same division are respectively termed second, third, fourth, &c. wranglers. In a similar manner, they who compose the second rank of honours are designated by the titles of first, second, third, &c. optimi. Those of the last order are distinguished by the denominations of first, second, third, &c. junior optimi.

WRANGON, in *Geography*, a small island in the gulf of Finland. N. lat. $59^{\circ} 34'$. E. long. 25° .

WRANNY, a town of Bohemia, in the circle of Schlan; 7 miles N.N.W. of Schlan.

WRANOW. See FRAIN.

WRAPPER, in *Botany*. See VOLVA.

WRASSE, in *Ichthyology*, the name of a fish called by authors *turdus vulgaris*, and by some *linca-marina*, the *sea-tench*, and sometimes *old-wife*.

The wrasse, or *labrus linca* of Linnæus, resembles the carp in figure, and is covered with large scales. Its usual size is about five or six inches in length, and it grows to the weight of four or five pounds: its colour is very variable; red, yellow, and brownish, being very frequently mixed in the scales; and it has five or six longitudinal lines, alternately of a pale yellow, an olive colour, and a dusky red. Its nose is long, and bent upwards, and it has thick and fleshy lips extended over the jaws. Its mouth is small, and its teeth, which are disposed in two rows, the first conic, the second very minute, are not very sharp; in the throat, just before the gullet, are three bones, two above of an oblong form, and one below of a triangular shape; with the surface of each rising into roundish protuberances: these are of singular use to the fish for grinding its shelly food before it arrives at the stomach; the dorsal fin consists of sixteen sharp and spiny rays, and nine soft ones, longer than the others: the pectoral fins are large and round, and composed of fifteen rays, the ventral of six; the first sharp and strong; the anal of three sharp spines, and nine flexible: its tail is rounded at the end, and is formed of fourteen soft branching rays; the membranes of the fins and tails are variegated with red and blue spots, and the anterior rays of the back-fin are prickly. It is caught in plenty on the English shores, and is sold among the poorer sort of people in Wales and Cornwall; but is not esteemed a very delicate fish. It is found in deep water, adjacent to the rocks; it will take a bait, though its usual food is shell-fish, and small crustacea. Willughby's *Hist. Pisc.* p. 320. and Pennant. See LABRUS.

WRASSE, *Bimaculated*, *labrus bimaculata* of Linnæus, has a body pretty deep, and of a light colour, marked in the middle on each side with a round brown spot, and another on the upper part of the base of the tail: the lateral line is incurvated; the branchiostegous rays are six; the first fifteen rays of the dorsal fin are spiny, the other eleven soft, and lengthened by a skinny appendage; the pectoral fins consist of fifteen rays; the ventral of six, the first spiny, the second and third ending in a slender bristle; the anal fin is pointed; the four first rays being short and spiny, the rest long and soft. This is an inhabitant of the Mediterranean.

Mr. Pennant has described some other species of wrasse, as the *trimaculated*, *striped*, and *gibbous*, taken on the coast of Anglesea, and another called *ballan*, numbers of which ap-

pear during summer near Scarborough, which is of the form of the common wrasse, except that between the dorsal fin and the tail it has a considerable sinking; above the nose a deep fulcus; and on the farthest cover of the gills a depression radiated from the centre. Pennant's *Brit. Zool.* vol. iii. p. 246, &c. See LABRUS.

WRATENI, in *Geography*. See FRATING.

WRATH, CAPE, a cape in the N.W. extremity of Scotland, in the parish of Durness, which affords excellent pasture for sheep. In its vicinity are vast caverns.

WRBOWALNOL, a town of Bohemia, in the circle of Koniggratz; 16 miles S.W. of Biezow.

WREAK, or WREKE, a river of Leicestershire, which passes by Melton Mowbray, and runs into the Soar, 7 miles N.E. of Leicester.

WREATH, in *Agriculture*, a small roll formed of any kind of light substance, such as straw, hay, &c. and used for different purposes.

WREATH, in *Natural History*. See TURBO.

WREATH, in *Heraldry*, a roll of fine linen, or silk, (like that of a Turkish turban,) consisting of the colours borne in the escutcheon; placed in an achievement, between the helmet and the crest, and immediately supporting the crest.

WREATH *Stick-Band*, in *Agriculture*, a band formed of any kind of twisted stick, used for tying up fagots, and other such purposes.

WRECK, WRACK, *Sea-WRECK*, or *Sea-OAK*, the *fuscus vesiculosus* of Linnæus, in *Natural History*, a soft, very slippery, marine plant, common among rocks that are left dry at the ebb tide, with leaves somewhat resembling those of the oak-tree; the stalk running along the middle of the leaves, and terminated by watery bladders containing either air or a slippery fluid: the vesicles begin in March to fill with a thin juice; and about the end of July they burst, and discharge a matter as thick as honey.

In some places it is used to manure the ground. In Normandy, and other parts, they burn it; and of the ashes make a kind of soda, or potash, which they use in the making of common green glass, to promote the fusion or vitrification of the other materials. See SEA-WEED.

Dr. Russel relates, that he found this plant an useful assistant to sea-water in the cure of disorders of the glands; that he gave it in powder to the quantity of a drachm, and that in large doses it nauseated the stomach; that by burning in the open air, it was reduced into the black saline powder; which seemed, as an internal medicine, greatly to excel the officinal burnt sponge; which was beneficially used as a dentifrice, for correcting laxities of the gums; and which indicated a remarkable degree of detergent virtue by its effect in cleaning the teeth: that the juice of the vesicles, after standing to putrefy, yielded, on evaporation, an acrid pungent salt, amounting to above a scruple from two spoonfuls; that the putrefied juice, applied to the skin, sinks in immediately, excites a slight sense of pungency, and deterges like a solution of soap; that one of the best applications for dissolving hardness, particularly in the decline of glandular swellings, is a mixture of two pounds of the juicy vesicles, gathered in July, with a quart of sea-water, kept in a glass vessel for ten or fifteen days, till the liquor comes near to the consistence of very thin honey: the parts affected are to be rubbed with the strained liquor twice or thrice a day, and afterwards washed clean with sea-water. Lewis's *Mat. Med.* See ÆTHIOPS *Vegetabilis*.

WRECK, in *Sea Language*, denotes the ruins of a ship which had been stranded or dashed to pieces on a shelf, rock, or lee-shore, by tempestuous weather.

WRECK, *Wreccum*, called also *Ship-WRECK*, or *Ship-WRACK*, in *Law*, &c. is when a ship perishes in the sea, and no man escapes alive out of it.

The civilians term it *naufragium*. The goods in the ship which are brought to the land by the waves belong to the king, or him to whom he assigns the right thereof. Thus, in the Stat. Prærog. Reg. 17 Edw. II. cap. 11. "Rex habebit *wreckum maris* per totum regnum, balænas et sturgesiones captas in mari, vel alibi intra regnum, exceptis quibuslibet privilegiatis locis," &c.

Thus also the matter stood by the ancient common law; but the rigour of the law of wrecks has been gradually softened in favour of the distressed proprietors. Accordingly it was first ordained by king Henry I. that if any person escaped alive out of the ship, it should be no wreck; and afterwards king Henry II. by his charter, May 26, A.D. 1174, declared, that if on the coasts of England, Poictou, Oleron, or Gascony, any ship should be distressed, and either man or beast should escape or be found therein alive, the goods should remain to the owners, if they claimed them within three months; but otherwise should be deemed a wreck, and belong to the king, or other lord of the franchise. This was again confirmed, with improvements, by Richard I., who, in the second year of his reign, not only established these concessions, by ordaining that the owner, if he was shipwrecked and escaped, "omnes res suas liberas et quietas haberet," but also, that if he perished, his children, or, in default of them, his brethren and sisters, should retain the property; and in default of brother or sister, then the goods should remain to the king. And by the law, as laid down by Bracton in the reign of Henry III., if not only a dog (*e. g.*) escaped, by which the owner might be discovered, but if any certain mark were set on the goods, by which they might be known again, it was held to be no wreck. Afterwards, in the statute of Westm. 1, 3 Edw. I. cap. 4, the time of limitation of claims, given by the charter of Henry II., is extended to a year and a day, according to the usage of Normandy; and it enacts, that if a man, a dog, or a cat, escape alive, the vessel shall not be adjudged a wreck. And it is now held, that not only if any living thing escape, but if proof can be made of the property of any of the goods or lading which come to shore, they shall not be forfeited as wreck. The statute farther ordains, that the sheriff of the county shall be bound to keep the goods a year and a day (as in France for one year, agreeable to the maritime laws of Oleron, and in Holland for a year and a half); that if any man can prove a property in them, either in his own right or by right of representation, they shall be restored to him without delay; but if no such property be proved within that time, they then shall be the king's. If the goods are of a perishable nature, the sheriff may sell them, and the money shall be liable in their stead. This revenue of wrecks is frequently granted out to lords of manors, as a royal franchise; and if any one be thus entitled to wrecks, in his own land, and the king's goods are wrecked thereon, the king may claim them at any time, even after the year and the day. In order to constitute a legal wreck, the goods must come to land. If they continue at sea, the law distinguishes them by the barbarous appellations of *jetsam*, *flotsam*, and *ligan*.

Wrecks, in their legal acceptation, are now not very frequent; the owner being seldom unable to assert his property within the year and day limited by law. And in order to preserve his property entire, our laws have made many humane regulations, very opposite in their spirit to those which formerly prevailed in all the northern regions of

Europe, and a few years ago were still said to subsist on the coasts of the Baltic sea; permitting the inhabitants to seize on whatever they could get as lawful prize. To what the reader will find under SALVAGE to this purpose, we shall here add, that all persons who secrete any goods of a wreck shall forfeit their treble value; and if they wilfully do any act whereby the ship is lost or destroyed, by making holes in her, stealing her pumps, or otherwise, they are guilty of felony without benefit of clergy. Moreover, by the statute 26 Geo. II. cap. 19, the plundering of any vessel either in distress, or wrecked, whether any living creature be on board or not, or the preventing the escape of any person that endeavours to save his life, or the wounding of him, with intent to destroy him, or the putting out of false lights in order to bring any vessel into danger, are all declared to be capital felonies, in like manner as the destroying of trees, steeples, or other stated sea-marks is punished, by 8 Eliz. cap. 13. with a forfeiture of 100*l.* or outlawry. Also by the statute of Geo. II. the pilfering of any goods cast ashore is declared to be petty larceny; and many other salutary regulations are made for the more effectually preserving ships of any nation in distress.

By the civil law, to destroy persons ship-wrecked, or prevent their saving of the ship, is capital; and to steal even a plank from a vessel in distress, or wrecked, makes the party liable to answer for the whole ship and cargo. The laws also of the Visigoths, and the most early Neapolitan constitutions, punished with the utmost severity all those who neglected to assist any ship in distress, or plundered any goods cast on shore. Blackst. Com. book i. p. 291, &c.

In divers charters and old writings, it appears that wreck, anciently, not only comprehended goods which came from a perishing ship, but whatever else the sea cast upon land: whether it were precious stones, fish, sea-weed, or the like.

This wreck, in the Grand Customary of Normandy, cap. 17. is called *varech*, and latined *veriscum*; and in some of our ancient charters, *wreche*, *werec*, *werech*, and *scup-werp*, q. d. *sea-upwerp*, of *sea* and *upwerpen*, to cast up.

Shipwreck, in marine insurance, and as it concerns the right of *abandoning*, is generally a total loss. What may be saved of the ship or goods is so uncertain, and depends so much on accident, that the law cannot distinguish this from the absolute destruction of the whole. The wreck of the ship may remain, but the ship is lost. Thus also the goods may remain; but if no ship can be procured, in a reasonable time, to carry them to their place of destination, the voyage is lost, and the adventure frustrated. But the mere *stranding* of the ship is not, of itself, deemed a total loss, so as to intitle the insured immediately to abandon. It is only where the stranding is followed by shipwreck, or in any other way renders the ship incapable of prosecuting her voyage, that the insured is intitled to abandon. If the voyage be lost, this is a total loss, not only of the ship and freight, but also of the cargo, if no other ship can be procured to carry it to its port of destination. Moreover, if a cargo be damaged in the course of the voyage, so that what has been saved is less in value than the amount of the freight, this is clearly a total loss. In case of shipwreck the rule in France is, that the insured may abandon, though the goods be recovered and carried to their place of destination, because goods thus saved are generally in a bad and unmarketable condition. But if the ship become un navigable, the insured cannot abandon the goods, if by any other ship they may be conveyed in time to their place of destination.

As it is reasonable and necessary that the time of the underwriter's responsibility should be limited, this limit is fixed in some maritime states on the continent, within which period after the loss the insured may abandon. In France, Spain, and Holland, the times are limited by law, according to the distance of the place where the loss happens, within which the abandonment must be made. In England there is no time, limited by law, for abandoning: but the courts have adopted a rule better suited to the promotion of commerce, and more likely to prevent frauds, which is this: that as soon as the insured receives advice of a total loss, he must make his election whether he will abandon or not: if he determines to abandon, he must give the underwriters notice of this "within a reasonable time" after the intelligence arrives; and any unnecessary delay in giving this notice will amount to a waiver of his right to abandon; for unless the waiver does some act signifying his intention to abandon, it will be only a partial loss, whatever may be the nature of the case, or the extent of the damage. If by any interference of the underwriters the insured be actually prevented from abandoning, the underwriters are liable for all the loss sustained by the insured to the extent of the sum insured. If the insured determine to abandon, and demand as for a total loss, he is not obliged, as in some foreign countries, to make a formal protest, but merely to give notice of the loss to the underwriters, and of his determination to abandon. The notice of abandonment may be given, either to the underwriter himself, or to the agent who has subscribed for him: and the abandonment ought to be made for the whole of the effects insured, and not for a particular part. The abandonment must be also simple and unconditional; otherwise it will not transfer the entire property to the insurers, which is of the essence of the abandonment. By the abandonment, the insured yields up to the insurers all his right, title, and interest in the ship or goods insured, or what may be saved of them, which, from the notice of abandonment, become the property of the insurers; but the abandonment of the ship does not, as in France, transfer to the insurer the freight she has earned. The abandonment not only intitles the underwriters to all that can be saved of the effects insured; but if compensation be made to the insured for the injury from which the loss arose, this compensation shall go to the underwriters; for when they have paid the loss, they, and not the insured, are the real sufferers. If the ship, after abandonment, arrive safe, the insurers shall have all the profit of the voyage. Nor shall they, on account of the safe arrival of the ship, refuse to pay the sum insured. So if the ship or goods insured happen to be recovered undamaged, after the insurer has paid a total loss, the insurer cannot compel the insured to refund the money, and take back the ship or goods, but the insurer shall stand in his place, and shall have the benefit of salvage. An abandonment once properly made, on sufficient ground, and accepted by the insurers, is absolute and binding upon both parties, and cannot be revoked unless by mutual consent; but if the ground be insufficient, it will be void. In case of shipwreck or other misfortune, the effects that are saved continue, till abandonment, the property of the insured, who is bound in justice, honour, and conscience, to use his utmost endeavours to make the most of what may be rescued from destruction; in order, as much as possible, to lighten the burden of the insurers. To enable him to do this, without prejudice to his right of abandonment, our policies provide, that in case of any loss or misfortune to the insured, their factors, servants, or assigns, shall be at liberty to sue, and labour about the defence, safeguard, and recovery of the goods and merchandizes, and

ship, &c. without prejudice to the insurance; "to the charges whereof, the insurers agree to contribute, each according to the rate and quantity of his subscription." Marshall on Insurance, vol. ii. See *Perils of the SEA*.

WRECK, in *Metallurgy*, a vessel in which the third washing is given to the ores of metals.

In Cornwall, when the tin-ore has been twice washed, they take the head tin, or that part of the tin-ore that lies uppermost, out of the buddle, and throwing it into this vessel, they pour water on it, and work it about with wooden rakes, till it is cleared from whatever other extraneous matter there may still have remained mixed with it, and is, after this, fit for the blowing-house to be run into metal.

WRECK, in *Agriculture*, a term signifying the weeds thrown up by the floods upon the sea-shores; also the dead indigested roots and stems of grass, and other plants in ploughed lands.

WREKIN, in *Geography*, a mountain of England, in Shropshire; about 10 miles E. of Shrewsbury.

WREME, a town of the duchy of Bremen; 5 miles N.N.W. of Carlsburg.

WREN, Sir CHRISTOPHER, in *Biography*, an eminent architect and mathematician, was born in 1632, at the living of his father, who was rector of East Knoyle, in Wiltshire, and finished his education at Wadham college, Oxford, into which he entered in 1646. Before this time, he had given proofs of genius by the invention of astronomical and pneumatic instruments; the former of which he dedicated to his father, at the age of 13, in a copy of elegant Latin verses, together with an exercise "De Ortu Fluminum." He also distinguished himself by the construction of other philosophical instruments; and in 1647 he wrote a treatise on Spherical Trigonometry upon a new plan. In 1650 he graduated B.A., and in 1651 wrote an algebraical tract on the Julian period. In 1653 he was elected fellow of All-Souls' college, and graduated M.A. He was one of the first members of the Philosophical Society at Oxford, from which proceeded the Royal Society, and contributed by his experiments and inventions to the amusement and instruction it afforded; and in 1663 he was elected a fellow of the Royal Society. In 1657 he was chosen astronomical professor at Gresham college; but upon being appointed Savilian professor of astronomy at Oxford, he resigned the former office, and in 1661 returned to the university, which created him doctor of laws. Wren next presents himself to our view as a pre-eminent architect; and thus distinguished, he received a commission in 1663 to prepare designs for the repair of St. Paul's cathedral; and after his return from a tour to France in 1665, with a view to his improvement in architecture, he finished those designs; but whilst they were under consideration, the edifice was destroyed by the fire of London in 1666. This catastrophe afforded him an opportunity of designing and constructing a building altogether new. The contemporary destruction of 50 parochial churches and many public buildings furnished ample scope for the exercise of Wren's talents; and he would have had the honour of re-founding, as it were, a new city, if the design which he laid before the king and parliament could have been accomplished without infringing on the rights of private property. On the death of sir John Denham in 1667, he succeeded to the office of surveyor of the works; and in order to obtain leisure for executing the various works in which he was employed, and more particularly the rebuilding of St. Paul's cathedral, he resigned his Savilian professorship in 1673. In 1674 he received the honour of knighthood, and in the following year the foundation of the new cathedral was laid. For a particular account of this magnificent

magnificent edifice, see the article LONDON. In 1680 sir Christopher's scientific merits caused him to be elected president of the Royal Society. In 1683 he was appointed architect and commissioner for Chelsea college, and in the following year comptroller of the works in the castle of Windsor. In 1685 he was introduced into parliament as a representative of Plympton. To his other public trusts were added, in 1698, that of surveyor-general and commissioner for the repair of Westminster abbey; in 1699 that of architect of Greenwich hospital; and in 1708 that of one of the commissioners for the 50 new churches proposed to be erected in and near the city of London. Having fulfilled all his duties to the 86th year of his age, the administration of 1718 incurred indelible disgrace, by suffering political consideration to have such influence as to deprive him of his place of surveyor to the royal works. The remaining five years of his life were spent in honourable retirement, and devoted to scientific pursuits, and the reading of the Scriptures. It is said that he indulged a very pardonable vanity by being carried once every year to survey St. Paul's cathedral. His life was prolonged to his 91st year, and terminated in consequence of a cold which he caught in coming from Hampton-Court to London, in February 1723. His remains were interred, with suitable funeral honours, under the choir of St. Paul's, and upon his tomb is a concise but very appropriate and expressive Latin inscription, ending "Lector, si monumentum requiris, circumspice." Sir Christopher was twice married, and left one son, a man of learning and piety, and a good antiquary. The edifices constructed by Wren were mostly public, including a royal hunting-seat at Winchester, and the modern part of the palace at Hampton-Court. Some of the most remarkable, besides St. Paul's, are, the Monument, the theatre at Oxford, the library of Trinity college, Cambridge, the hospitals of Chelsea and Greenwich, and of Christchurch, London, the church of St. Stephen, Walbrook, those of St. Mary-le-Bow, St. Michael, Cornhill, and St. Bride, distinguished by their steeples, and the great campanile of Christchurch, Oxford. Of the rank which he occupied as a man of science, we may form some judgment from the succeeding concise detail of his performances, and more particularly from the testimony of sir Isaac Newton, who, in his "Principia," joins the names of Wren, Willis, and Huygens, and characterizes them as "hujus ætatis Geometrarum facile principes." As to his moral character, it is said to have been worthy of his intellectual eminence; as with great equanimity, he was pious, temperate, modest, and communicative of his knowledge; and few men seem to have been more generally esteemed by their contemporaries. With regard to his architectural skill and attainments, a very competent judge, being himself of the profession, says, that he possessed an inexhaustible fertility of invention, combined with good natural taste and profound scientific knowledge; and that his talent was particularly adapted to ecclesiastical architecture, which afforded domes and towers to his picturesque fancy; while, in his palaces and private houses, he has sometimes sunk into a heavy monotony, as at Hampton-Court and Winchester. Among the rich variety of Wren's towers, steeples, and spires, many are truly elegant. The church of St. Stephen's, Walbrook, exhibits a deviation from common forms equally ingenious and beautiful. The Monument is grand and simple. At Greenwich, his additions to the original work of Inigo Jones are singularly grand and beautiful. Upon the whole, sir C. Wren's architecture is perhaps the perfection of that modern style which, with forms and modes of construction essentially Gothic, adopts for the decorative

part the orders and ornaments of antiquity. Biog. Brit. Walpole's Anecd. Gen. Biog.

WREN, or *Jenny-Wren*, in Ornithology, the *passer troglodytes* of Gefner, and the *motacilla troglodytes* of Linnæus, has the head and upper part of the body of a deep reddish-brown; above each eye is a stroke of white; the back, and coverts of the wings and tail, are marked with slender, transverse, black lines; the quill-feathers with bars of black and red; the throat is of a yellowish-white; the belly and sides crossed with narrow dusky and pale reddish-brown lines; and the tail is crossed with dusky bars. Pennant.

This bird, though very small, is of a very cheerful disposition, and has a very agreeable voice, which he throws out with great cheerfulness and sprightliness, usually cocking up his tail all the time he is singing, and continues his song through the winter, except during the frosts. See SONG of Birds.

The female breeds twice in the year, first in the latter end of April, and afterwards in the middle of June. The nest is usually placed among clusters of moss and ivy, in such a manner that it is very hard to discover it. It is made of dry moss and leaves put together in a very artificial manner, being closed all round except for a small hole left to go in and out at. They lay a great number of eggs, not less than eighteen; and it has been often found that they all hatch except one or two; and thus sixteen young ones have been found together in the nest. These are brought up so well as to shift for themselves by the end of May; and then another brood is provided for by the middle of the month following. The young ones may be easily raised. They should for this purpose be taken out of the nest at about fourteen days old, and fed with sheep's, calf's, or ox's heart, cut small, with eggs minced among it. When they are able to peck this meat for themselves, they may be put into cages; but they must still be fed for some days, lest they should neglect themselves, and die of hunger after the greatest part of the trouble is thus over. See MOTACILLA *Troglodytes*.

When they are grown up, they may be fed with paste, and will need no more heart. Afterward it will be a great feast to them to give each a spider or two at once in two or three days; and after they attain full age, they may either be left to sing their own wild notes, which are very agreeable, or if it be desired that they should whistle tunes, they will easily be taught it. Ray and Pennant.

WREN, *Crested*, or *Golden-Crested WREN*, *regulus cristatus*, or *motacilla regulus* of Linnæus, the name of a very beautiful little bird, the smallest of all the British birds. Its whole weight is not more than seventy-six grains; and the crown of its head is adorned with a very beautiful saffron-coloured or orange-red spot, which is called its crest, and by some its crown, and from this golden crown the bird has obtained the name of the *regulus*, *tyrannus*, *basileus*, and other appellations of royalty. This beautiful scarlet mark on the head is bounded on each side by a fine yellow line. The bill is dusky; the feathers of the forehead are green; from the bill to the eyes is a narrow white line; the back and hind part of the neck are of a dull green; the coverts of the wings dusky, edged with green, and tipped with white; the quill-feathers and tail dusky, edged with pale green; the throat and lower part of the body white, tinged with green; the legs are of a dull yellow colour; and the claws are very long.

This bird frequents woods, and is found principally in oak-trees. It is common about the Peak in Derbyshire, and is seen in autumn as far north as the Shetland isles, but quits that country before winter. It lays six or seven eggs,

not larger than peas. This bird has been observed suspended in the air for a considerable time over a bush in flower, whilst it sung very melodiously. The note does not much differ from that of the common wren, but is very weak. Ray and Pennant. See *MOTACILLA Regulus*.

WREN, *Yellow*. See *LUTEOLA*, and *MOTACILLA Trochilus*.

WRENCH. See *STRAIN*.

WRENTHAM, in *Geography*, a town of the state of Massachusetts, in the county of Norfolk, containing 2478 inhabitants; 23 miles S.W. of Boston.

WRESTBALKING, in *Agriculture*, the operation of turning over upon or covering a balk or rib of whole un-moved ground, by a broad furrow-slice, in the view of rendering the land more mellow and porous. The term is chiefly used in the eastern districts of the country.

WRESTLING, a kind of combat or engagement between two persons unarmed, body to body, to prove their strength and dexterity, and try which can throw his opponent to the ground.

Wrestling, *palastra*, is an exercise of very great antiquity and fame. It was in use in the heroic age; witness Hercules, who wrestled with Antæus.

It continued a long time in the highest repute, and had very considerable rewards and honours assigned it at the Olympic games. It was the custom of the athletes, or wrestlers, to anoint their bodies with oil, to give the less hold to their antagonist. See *PALÆSTRA*.

Ablancourt observes, that Lycurgus ordained the Spartan maids to wrestle in public, quite naked, to break them of their too much delicacy and niceness; to make them appear more robust, and familiarize the people, &c. to such nudities.

A wrestling match, or *neobering*, is a very common diversion in the Mandingo countries of Africa. It is exhibited at the "Bentang," which is a large stage found in each town, that answers the purpose of a public hall or town-house: it is composed of interwoven canes, and is generally sheltered from the sun by being erected in the shade of some large tree. It serves also for a kind of lounging place, where the indolent and unemployed assemble to smoke their pipes, and talk over the news of the day.

At the wrestling match, the spectators arrange themselves in a circle, leaving the intermediate space for the wrestlers, who are strong, active, young men, trained up from infancy to this sort of exertion. Being stripped of their clothing, except a short pair of drawers, and having their skin anointed with oil, or *shea* butter, they approach each other on all fours, parrying with and occasionally extending a hand for some time, till at length one of them springs forward and catches his rival by the knee. Great dexterity and judgment are now displayed; and the contest is at length decided by superior strength. The combatants are animated by the music of a drum, which serves also in some measure to regulate their motions. The wrestling is succeeded by a dance, in which many performers assist, all being provided with little bells fastened to their legs and arms; their motions being regulated by the drum, beaten by a crooked flick, which the drummer holds in his right-hand, occasionally using his left to deaden the sound, and thus vary the music. The drum is also used to keep order among the spectators; and when the wrestling match is about to begin, the drummer strikes what is understood to signify "ali bæ fee," fit all down; upon which the spectators immediately seat themselves; and when the combatants begin, he strikes "amuta, amuta," *i. e.* take hold, take hold.

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WRETESTA, in *Geography*, a town of Sweden, in Sudermannland; 36 miles N.W. of Nykioping.

WRETSTORP, a town of Sweden, in the province of Nericia; 16 miles S.W. of Orebro.

WRETWEED, in *Agriculture*, a name sometimes given to wart-weed or sun-spurge, a troublesome weed in fields. See *WEED*.

WREXHAM, in *Geography*, a market-town in the hundred of Bromefield, towards the east corner of the county of Denbigh, North Wales, is situated 25 miles E.S.E. from Denbigh, 11 $\frac{3}{4}$ S.S.W. from Chester, and by the road through Whitechurch 176 N.W. from London. The parish of Wrexham is extensive and populous, and comprises 14 townships. By the returns of 1811, the population of the whole amounted to 19,495, and the houses to 4142.

Wrexham is a place of considerable antiquity, for it is mentioned in the Saxon Chronicle by the name of Wrigh-teletham. Although belonging to Cambria, yet being separated by the ancient trench called Offa's Dyke, it came to be ranked as appertaining to the great internal district of England, Mercia. In the reign of Edward I., the town and the lordship were granted to earl Warren; and as early as the reign of Henry VIII., the town was known for its trade, particularly for its buckle-makers. Wrexham is noted for its fairs, one of which continues for nine days, for the sale of Welsh flannels, cattle, Irish linens, English woollens, ironmongery, &c. The weekly markets are kept on Monday and Thursday. The church of Wrexham is the most remarkable and most ornamented building of its kind in North Wales. It was erected in 1472, but the tower was not finished till 1506. It consists of a nave, with side aisles, and a chancel; the whole length being 178 feet, and the breadth 72: the tower rises to the height of 135 feet; the aisles are separated from the nave by clustered columns supporting pointed arches; the ceiling is composed of oak, in imitation of groined stone. In the town is a free-school for educating twelve boys. Two miles west from Wrexham is Borsham, which is noted for the great iron-furnaces of Messrs. Wilkinson. Notwithstanding the difficulties in the beginning, the works are now among the greatest in the kingdom. The machinery employed is very ingenious; and every article of cast-iron, from cannon down to kitchen utensils, is fabricated in great numbers. Iron-stone and coal are plentiful in the neighbourhood; and at a short distance is a productive lead-mine. The Ellesmere canal between Shrewsbury and Chester passes half a mile to the west of Wrexham. Two miles more to the westward is the celebrated intrenchment called Offa's Dyke, which extended from the river Wye in Monmouthshire on the south into Flintshire on the north; and is supposed to have been formed by that Saxon chief of Mercia, to defend his country from the native Britons, who had retired among the mountains of Wales. On the east side of Wrexham is Wat's Dyke, another intrenchment of the same kind, probably intended for a similar purpose, but unconnected with the work of Offa.

About seven miles S.S.W. from Wrexham is Ruabon, a village with a respectable church, containing the monuments of the ancient families of Williams and Wynn; one in particular for the first sir Watkin, who died in 1749, is a distinguished production of Rysbrack. The learned Dr. David Powell, the translator and editor of sundry historical works relative to Wales, was a native and vicar of Ruabon, where he died in 1590. On the east side of the village is the gate leading to the park and mansion of Wynnistay, the seat

of sir Watkin Williams Wynn, bart. The road runs through an avenue of trees of uncommon growth, in a straight line for a mile, to a spacious lawn, on which stands the house. Erected at different periods, and in different styles of architecture, Wynnstay-hall is more distinguished for size and irregularity than for beauty of architecture. The new parts erected by the first baronet, although only a portion of the design, form a plain, substantial, comfortable place of residence; the older parts are chiefly appropriated to menial purposes. The interior comprehends some spacious apartments, in which are a few valuable portraits, particularly one by Vandyke of sir Richard Wynn, who attended Charles I. on his romantic matrimonial adventure to Spain. Adjoining to the house is a small building, formerly used as a theatre. The park, from the ancient intrenchment Wat's Dyke which traverses it, was formerly called Wat-stay; but when the heiress married sir John Wynn, who inclosed the grounds in 1678 with a stone-wall, the name was changed to its present appellation. The grounds are not greatly diversified, but they are well wooded, and favourably situated for prospects. On an eminence stands a fluted stone column, 100 feet high, on a plinth 16 feet square, accessible to the summit by an internal stair-case. It was erected in memory of the late baronet by his mother, with this simple but eloquent inscription: "Filio optimo mater cheu! superstes." Near the park the river Dee winds through Nant-y-Bele, or the dingle of the Marten, a place of great natural romantic beauty. Caer-ddin in this parish, commonly called Garthen, is a strong British post on a lofty hill, at no great distance from Offa's Dyke. It is formed by a rampart and ditch, in some parts double, and the inner consisting of a thick wall. The area, containing about four acres, exhibits vestiges of ancient buildings.—*Beauties of England and Wales, Denbighshire*, by the Rev. J. Evans, 8vo. London, 1812.

WRIETZEN. See BRIETZEN.

WRIGHT, EDWARD, in *Biography*, an English mathematician, flourished in the latter part of the 16th and beginning of the 17th century. Of his private history little is known, except some few particulars that may be collected from the Latin memoirs of his life, preserved among the annals of Gonville and Caius college in Cambridge. This year (1615) died, it is said, at London, Edward Wright, of Garvelton in Norfolk, formerly a fellow of this college, much respected for the integrity and simplicity of his manners, and also famous for his skill in the mathematical sciences. He was the first undertaker of the difficult but useful work, by which a little river is brought from the town of Ware, in a new canal, to supply the city of London with water; but by the tricks of others he was prevented from completing it. Nor was he inferior to the most ingenious mechanic in the construction of instruments, either of brass or of any other matter. He, it is said, taught Iodocus Hondius the method of constructing his geographical charts, though Hondius concealed his name, that he might arrogate to himself the honour of the invention. Of this act of injustice, Wright complained in the Preface to his "Treatise of the Correction of Errors in the Art of Navigation," a work composed with excellent judgment, and after long experience, to the great advancement of naval affairs. For his improvement of this art he was appointed mathematical lecturer to the East India Company; and he read lectures, for which he was allowed a yearly salary of 50*l*. This office he discharged with great reputation, and much to the satisfaction of his hearers. He published, in English, a book on the doctrine of the sphere, and another

concerning the construction of sun-dials. He also prefixed an ingenious preface to the learned Gilbert's book on the load-stone. By these and other writings he transmitted his fame to the latest posterity. It is added, whilst he was a fellow of this college, he was called forth to the public business of the nation by the queen, about the year 1593, or, according to other accounts, 1589. He was ordered to attend the earl of Cumberland in some maritime expeditions; of one of which he gave a faithful account, under the form of a journal or ephemeris, prefixing to it an elegant hydrographical chart of his own invention. His posthumous work, which was an English translation of the book of logarithms, then lately discovered by lord Napier, a friend of Mr. Wright, was published soon after his death by his son Samuel Wright, a scholar of the above-named college. Death prevented the execution of several other designs which he had formed. Of him it may be truly said, that he studied more to serve the public than himself; and though he was rich in fame and in the promises of the great, he died poor, to the scandal of an ungrateful age. To the preceding extracts from the memoirs above cited, we may add, that Mr. Wright first discovered the true method of dividing the meridian line, according to which Mercator's charts are constructed (see CHART), and upon which his sailing is founded. An account of it was sent from Cambridge to Mr. Blondville, who published it among his exercises in 1594; and in 1597 a demonstration of it was given by the Rev. Mr. William Barlowe, in his "Navigator's Supply." In 1599 Mr. Wright published "The Correction of certain Errors in Navigation," written many years before, and shewing the reason of his division of the meridian, the manner of constructing his table, and its uses in navigation, &c. &c. In 1610 he dedicated a second edition to his royal pupil, prince Henry, with farther improvements, and an excellent method for determining the magnitude of the earth. To his other works, comprehending an account of his various discoveries, tables, and improved instruments for observation, we shall add his tract on navigation, entitled "The Haven-finding Art." It is said that he constructed, for the use of prince Henry, a large sphere with curious movements, serving by spring-work to exhibit the motions of the whole celestial sphere, the particular systems of the sun and moon, their circular motions, places, and possibilities of eclipsing each other. (See ORRERY.) This sphere was overlooked in the time of the civil wars, and found among dust and rubbish in 1646 by sir Jonas Moore, who was at the expence of restoring it to its original state, and deposited it at his own house in the Tower, among other mathematical instruments. Preface to Robertson's Navigation. Hutton's Math. Dict.

WRIGHT, RICHARD, was a native of Liverpool, and born about the year 1735. He was bred to the humble occupation of a house and ship painter, but exerted his talents in painting sea views, and obtained for his encouragement the premium offered in 1764 by the society for the encouragement of arts, &c.; and in 1766 he gained another premium of fifty guineas, for a picture which had the greater credit of being most beautifully engraved by Woollett, and is known under the name of the "Fihery." He died about 1775.

WRIGHT, JOSEPH, one of our earliest painters of celebrity in this age of restoration of the art. He was born at Derby in 1734, and thence obtained the name of Wright of Derby, to distinguish him from R. Wright mentioned above. He came to London to study with Hudson, but afterwards established himself at his native place, and had very considerable

siderable encouragement as a portrait-painter, though his style was dry and too minute. He gained much more reputation by painting scenes of fire and candle-light, and indeed stood unrivalled in that way till Louthembourg subsequently appeared. His pictures of a forge and of a blacksmith's shop, exhibited with the society of artists about the year 1765, established his reputation. In 1773 he visited Rome, and Italy generally, and was absent two years. In 1782 he was elected an associate of the Royal Academy, but resigned his diploma soon after, on Mr. Garvey's being preferred to him in an election for an academicians; though he continued occasionally to exhibit with the academy. He had great industry and professional skill, living very much apart from the world. This enabled him to produce many pictures, and in 1785 he made an exhibition of twenty-four pictures of his own painting at the great room under the Piazza Covent-garden, one of which was a large work representing the destruction of the floating batteries before Gibraltar. His style in all his works was peculiar to himself, somewhat dry, yet not void of richness, and his drawing coldly correct. One peculiarity marks his pictures, and renders them easily distinguishable, especially those in which the illumination proceeds from the moon or fire. He prepared his cloths or grounds with rough surfaces, caused by sand sifted or strewed upon them; and then when he had painted his scene, he dragged his pallet-knife, covered with the colour of the light, across the picture, when the colour adhering to the projections on the surface, gave the glitter which characterizes that kind of illumination, and he toned the parts to due relief by glazings. No one ever gave the exact tone of moon-light so completely as Wright of Derby. He died in 1797, aged 63.

WRIGHT, *Mifs*, a vocal apprentice to Michael Arne, the natural son of Dr. Arne. She had a sweet, spirited, and active voice, but was so young in music, that she learned the parts which she had to perform on the stage, after she was too hastily engaged at Drury-lane, by her ear. The first part assigned to her in that theatre was Leonora, in Bickerstaff's Padlock, in which the airs, as set by Dibden, were so pleasing, and so much on the Italian model, that they established her in the favour of the town. But the air "Say little foolish fluttering thing" was never sung in such a brilliant and captivating manner by any other singer.

In 1766 she appeared in the Cunning Man, Rousseau's Devin de Village, translated *totidem syllabis*, and adapted to his original music by the author of this article, in which she pleased extremely.

Soon after this, the apprentice was exalted into the wife of her master, the *serva padrona*, and sung with great applause in Cymon, and several of his and other composers' compositions that were performed at Drury-lane; and, if we remember right, in the summer she sung in Mary-le-bone gardens. But the town was so fond of hearing her, and the produce of her talents so alluring to her husband, that she may truly be said to have sung herself to death; or, like the swans of old in the Po, to have died singing. The truth is, that her ignorance of music made it necessary for her to sing at home, in rendering herself perfect in her parts, ten times more than she did in public, which brought on a pulmonary complaint, and prematurely put an end to her existence in 1770, at the age of 22, to the grief of her friends, and great regret of the public.

WRIGHT, in *Geography*, a town of Virginia; 44 miles W. of Richmond.

WRIGHT'S TOWN, a township of Pennsylvania, in the county of Bucks, with 562 inhabitants; 24 miles N. of Eatton.

WRIGHTIA, in *Botany*, is dedicated by Mr. Brown to his much-respected friend William Wright, M.D. fellow of the royal societies of London and Edinburgh, and associate of the Linnæan society, "whose ardour in the pursuit of botanical knowledge," says Mr. Brown, "even while engaged in extensive medical practice in the island of Jamaica, has long entitled him to this mark of distinction." We heartily concur in this sentiment, and cannot but regret that Dr. Swartz did not retain for this purpose what he has called MERIANA. (See that article.)—Brown in Tr. of the Wernerian Soc. v. 1. 73. Prodr. Nov. Holl. v. 1. 467. Ait. Hort. Kew. v. 2. 68. (Nerium; Gærtu. t. 117.)—Clafs and order, *Pentandria Monogynia*. Nat. Ord. *Convolvutæ*, Linn. *Apocineæ*, Juss. Brown.

Gen. Ch. *Cal.* Perianth inferior, of one leaf, in five small, rounded, bluntish segments, with five or ten internal scales at the outside of the base of the corolla, permanent. *Cor.* of one petal, falver-shaped: tube cylindrical, various in length: limb in five oblong, spreading, oblique segments, as long as the tube, or longer: mouth crowned with ten divided scales, shorter than the limb. *Stam.* Filaments five, thread-shaped, short, inserted into the throat of the corolla; anthers arrow-shaped, pointed, prominent, cohering by their middle part to the stigma. *Pist.* Germens two, superior, roundish, cohering; style one, thread-shaped, the length of the tube, dilated at the apex; stigma contracted. *Peric.* Follicles two, almost cylindrical, either distinct or cohering, pointed, erect. *Seeds* numerous, inserted into the margins of each follicle, oblong, imbricated downwards, crowned at the lower extremity with silky hairs, directed towards the base of the seed-vessel.

Ess. Ch. Corolla oblique, falver-shaped; mouth crowned with ten divided scales. Stamens prominent. Follicles two, erect. Seeds imbricated downward, hairy at the lower extremity.

A genus of upright shrubs, or small trees, natives of the East Indies, Ceylon, the Malay archipelago, or the tropical part of New Holland. Their leaves are opposite. *Flowers* white, corymbose, nearly terminal. *Albumen* none. *Embryo* white, turning rose-coloured by immersion in warm water; *cotyledons* involute longitudinally. *Brown.*

1. *W. antidysenterica*. Oval-leaved Wrightia. Br. n. 1. Ait. n. 1. (Nerium antidysentericum; Linn. Sp. Pl. 306, excluding Rheede's synonym. Willd. Sp. Pl. v. 1. 1236. N. n. 107; Linn. Zeyl. 45. N. indicum, filiquis angustis, erectis, longis, geminis; Burm. Zeyl. 167. t. 77.)—Leaves obovate-oblong, short-pointed, smooth. Corymbs mostly terminal. Tube of the corolla six times as long as the calyx. Follicles distinct.—Native of Ceylon. A handsome erect shrub, with numerous branches. *Leaves* on short stalks, spreading, two inches, or two and a half, long. *Tube* as well as *limb* of the *flowers* each an inch in length. *Follicles* thrice as long, a little swelling upwards; their points converging. *Brown. Burmann.*

2. *W. zeylanica*. Lanceolate-leaved Wrightia. Br. n. 2. (Nerium zeylanicum; Linn. Sp. Pl. 306. Am. Acad. v. 4. 309. Willd. Sp. Pl. v. 1. 1236. Apocynum arborescens, nerii flore minus; Burm. Zeyl. 23. t. 12. f. 2.)—Leaves oblong-lanceolate, blunt-pointed, smooth. Corymbs terminal. Tube of the corolla four or five times as long as the calyx. Follicles distinct.—Native of Ceylon. Our specimen was given to Linnæus by Burmann. The branches are long and straight, round, purplish. *Leaves* smaller than the last, about an inch and a half long, with more or less of a linear blunt point. *Flowers* like the preceding, but, according to Mr. Brown, the *tube* is shorter in proportion.

3. *W. tinctoria*. Dyer's Wrightia. Br. n. 3.—"Leaves elliptic-

elliptic-lanceolate, or ovate, pointed, smooth. Branches and corymbs divaricated. Tube of the corolla twice the length of the calyx. Follicles distinct."—Found by Koenig and Roxburgh in the East Indies. We received from Dr. Roxburgh in 1789, by the name of *Nerium antidysentericum*, specimens which answer to the above characters, except that the *tube* is not at all longer than the *calyx*; the *limb* moreover appears purplish, and is clothed on both sides with fine pubescence. This plant must be known to Mr. Brown, and perhaps is one of the undescribed species of which he makes mention.

4. *W. pubescens*. Downy Wrightia. Br. n. 4. Prodr. n. 1.—"Leaves elliptic-oblong, pointed, downy as well as the calyx. Corymbs erect. Tube of the corolla scarcely longer than the calyx. Follicles combined."—Gathered by Mr. Brown in the tropical part of New Holland, and in the isle of Timor, near Coepang.

This author speaks of some other species, of which he has not yet published either characters or names, and which are not known to us. *Nelum-Pala*, Rheede Hert. Mal. v. 9. 5. t. 3 and 4, is presumed to belong to the present genus.

WRIGHTSBOROUGH, in *Geography*, a settlement in the state of Georgia, on a branch of the Savannah; 30 miles W. of Augusta.

WRING-HOUSE, in *Rural Economy*, a name sometimes applied to the place for making cyder in, in the southern districts.

WRINGLE-TAIL, a name given by the people of several parts of England to the *curvicauda*, a species of bee-fly, very much resembling the bee in shape, but having only two wings and no sting. It is very troublesome to horses, but does not suck their blood, but only lays its eggs in their skins: it is called in other countries the *wbame* and the *barrel-fly*.

WRINGTON, in *Geography*, a market-town in the hundred of Brent-with-Wrington, in the county of Somerset, England, is situated to the S.W. of the Mendip hills, at the distance of 6 miles N.N.E. from Axbridge, and 129 miles W. from London. The streets are irregularly built, and most of the houses are thatched. A weekly market, by a very ancient grant, is held on Tuesday; and here is an annual fair. In the market-place are the ruins of a cross. The church, a spacious edifice, 120 feet in length and 52 in width, consists of a nave, chancel, side aisles, and a porch. The tower, at the west end, is 140 feet high to the top of the battlements, which are adorned with four turrets, one at each corner, and sixteen elegant pinnacles fifteen feet in height. The church contains several ancient and modern monuments. One is of peculiar beauty: it is built of white and Sienna marble, and was erected in memory of Dr. Henry Waterland, prebendary of Bristol, and above fifty years minister of this parish, where he constantly resided: he died March 27, 1779. In the town is a free-school for six boys and as many girls. In the return of the year 1811, the population of the parish is enumerated as 1109, the number of houses as 183. Wrington is distinguished by being the birth-place of the celebrated philosopher, John Locke: he was born 1632, in an old thatched house, still standing on the north side of the church-yard: he died October 28, 1704. See LOCKE, JOHN.—Collinson's History of Somersetshire, vol. i. 1791.

WRIST, CARPUS, in *Anatomy*. See EXTREMITIES.

WRIST, *Fracture, Ligaments, and Luxation of*. See the respective articles.

WRIST, in the *Manege*. The bridle wrist is that of the cavalier's left-hand. A horseman's wrist and his elbow

should be equally raised, and the wrist should be two or three fingers above the pommel of the saddle. To ride a horse from hand to hand, *i. e.* to change hands upon one tread, you need only to turn your wrist to that side you would have the horse to turn to, without advancing your hand. But if your horse stops, you must make use of both your legs. See HAND and LEGS.

WRIT, formed from the Saxon *writan*, to write, *Breve*, in *Law*, a precept of the king in writing, under seal, issuing out of some court to the sheriff or other person, whereby any thing is commanded to be done, touching a suit or action, or giving commission to have it done: as, the summoning of a defendant, taking a distress, redressing a disseisin, or the like. Or, according to Fitzherbert, a writ is a formal letter of the king in parchment, sealed with a seal, and directed to some judge, officer, or minister, &c. at the suit or plaint of a subject, requiring to have a thing done, for the cause briefly expressed, which is to be discussed in the proper court according to law. See BREVE, BRIEF, and PRECIPE.

Writs are variously divided, and in various respects. Some, with regard to their order, or manner of granting, are termed *original*, and others *judicial*.

WRITS, *Original*, are those sent out of the high court of chancery, to summon the defendant in a personal or tenant in a real action; either before the suit begins, or to begin the suit by it. See ORIGINAL.

Royal writs are held to be demandable of common right, on paying the usual fees; for any delay in the granting of them, or setting an unusual or exorbitant price upon them, would be a breach of Magna Charta, cap. 29. "Nulli vendemus, nulli negabimus, aut differemus justitiam vel rectum."

Original writs are either optional or peremptory, or, in the language of our law, they are either a *precipe*, or a *scite fecerit securum*.

WRITS, *Judicial*, are those sent by order of the court where the cause depends, upon emergent occasions, after the suit begins.

Judicial writs are distinguished from *original*, in that their teste bears the name of the chief-justice of that court whence they come; whereas the *original* say, *teste meipso*, in the name or relating to the king.

The *original* writ is always made returnable at the distance of at least fifteen days from the date or *teste*, and upon some day in one of the four terms: and all *judicial* writs, being grounded on the sheriff's return, must respectively bear date the same day on which the writ immediately preceding was returnable. See PROCESS.

Judicial writs, if erroneous, may be amended: whereas *original* writs are not amendable, if the error be by default of the party who gave instruction; yet a new *original* may be taken out, where it is not amendable.

Writs are also distinguished, according to the nature of the action, into *real* and *personal*.

Real, are either touching the possession, called *writs of entry*; or the property, called *writs of right*. See RECTO.

Personal writs, are those relating to goods, chattels, or personal injuries.

To which may be added *mixt* writs, for the recovery both of the thing and damages.

Some writs, again, are at the suit of the party; some, of office; some, ordinary; some, of privilege. A writ of privilege is that which a privileged person brings to the court for his exemption, by reason of some privilege which he enjoys.

But the most common writs in daily use are, in debt, detinue,

tinue, trespass, action upon the case, account, and covenant, &c. which, as well as others, must be rightly directed, or they will be naught.

Writs may be renewed every term, until a defendant is arrested; but in the court of king's bench, if the *latitat* be not renewed in five terms, a new writ is to be taken out, and the plaintiff is not allowed to renew the old one.

The sheriff's bailiffs cannot execute a writ directed to the sheriff, without his warrant; and if several persons are included in a writ (for four defendants may be in one writ), there must be several warrants from the sheriff to execute the same. All writs are to be returned and filed in due time, to avoid *post-terminum*.

Attachment lies against sheriffs, &c. for not executing a writ, or for doing it oppressively by force, extorting money on it, or not doing it effectually, by reason of any corrupt practice.

WRIT of *Appraisement*, a writ issued out of court for the valuation of goods seized as forfeited to the crown; or goods taken as prize of war, or found wrecked, flotsam or jetsam.

Several seizures by several persons not amounting to 100*l.* may be included in one writ. (Bunbury, p. 63.) And a new writ was ordered where the first appraisement was too high. (Ibid. 49. 185.) They are also required to specify the goods particularly, p. 89.

WRIT of *Affise*. See ASSISE.

WRITS of *Affisance*, are writs issued out of the exchequer, to enable officers to enter ships, houses, warehouses, and other places, to search for smuggled or prohibited goods. They are directed to be granted by 13 & 14 Car. II. c. 11. and are issued on oath, that there is strong presumption to believe goods of those kinds are harboured; but if they are executed in the night, the officers must be accompanied by a peace-officer.

WRIT of *Capias*. See CAPIAS.

WRIT of *Delivery*, a writ directing the delivery of goods out of the king's possessions, either by verdict or by consent. They cannot be issued till the information is in court (Bunbury, p. 27.); and they are discretionary in the court. (Ibid. p. 196.) A writ was granted out of the exchequer for watches, because the springs and steel-work were liable to rust (p. 74.); but it was refused for tobacco-stalks, because they were directed to be burnt. (P. 196.) A writ was also refused in Ladd's and in Thomsett's case, in the same court, for coins; the former reported, the latter not reported.

WRIT of *Distringas*. See DISTRINGAS.

WRIT of *Election to Parliament*. See PARLIAMENT.

WRIT of *Entry*. See ENTRY.

WRIT of *Inquiry of Damages*, a judicial writ that issues out to the sheriff upon a judgment by default, in an action of the case, covenant, trespass, trover, &c. commanding him to summon a jury to enquire what damages the plaintiff hath sustained, *occasione premissorum*; and when this is returned with the inquisition, the rule for judgment is given upon it; and if nothing be said to the contrary, judgment is thereupon entered. 2 Lill. Abr. 721.

WRIT of *Mainprise*. See MAINPRISE.

WRIT of *Neifty*. See NEIFTY.

WRIT of *Rebellion*. See COMMISSION of *Rebellion*.

WRIT of *Right*. See RECTO.

WRITS *Vicountiel*. See VICOUNTIEL.

WRIT, *Action of a*. See ACTION.

WRIT, *Appeal by*. See APPEAL.

WRIT, *Attachment by*. See ATTACHMENT.

WRIT, *Continuance of a*. See CONTINUANCE.

WRITER of the *Tallies*, an officer of the exchequer, being clerk to the auditor of the receipt, who writes upon the tallies the whole letters of the tellers' bills. See TALLY and EXCHEQUER.

WRITING, SCRIPTURA, the art or act of signifying and conveying our ideas to others, by letters or characters visible to the eye.

Or, writing may be defined to be the art of exhibiting to the sight the conceptions of the mind, by means of marks or characters significant of the sounds of language, which enable us to transfer ideas from the eye to the ear, and *vice versa*.

Written characters are of two sorts: they are either signs for things, or signs for words. Of the former sort, are the pictures, hieroglyphics, and symbols, employed by the ancient nations; of the latter sort, are the alphabetical characters now employed by all Europeans. Pictures were, undoubtedly, the first essay towards writing; accordingly, we find in fact, that this was the only sort of writing known in the kingdom of Mexico, when America was first discovered. By historical pictures, the Mexicans are said to have transmitted the memory of the most important transactions of their empire. (See Warburton's *Divine Legat. of Moses*, vol. ii. part i. p. 67, &c. vol. iii. p. 73. Robertson's *Hist. Am.* vol. iii. p. 203, &c. and Appendix, note 26. p. 440. edit. 3vo.) But as pictures could do no more than delineate external events, without exhibiting their connections, describing such qualities as were not visible to the eye, or conveying any idea of the dispositions or words of men, there arose in process of time, for supplying this defect, the invention of hieroglyphical characters; which may be considered as the second stage of the art of writing.

Hieroglyphics (which see) consist in certain symbols, which are made to stand for invisible objects, on account of an analogy or resemblance which such symbols were supposed to bear to the objects. Among the Mexicans were found some traces of hieroglyphical characters, intermixed with their historical pictures. But Egypt was the country where this sort of writing was most studied, and brought into a regular art. However, this sort of writing could be no other than enigmatical and confused, in the highest degree; and must have been a very imperfect vehicle of knowledge of any kind.

As writing advanced from pictures of visible objects to hieroglyphics, or symbols of things invisible; from these latter it advanced, among some nations, to simple arbitrary marks which stood for objects, though without any resemblance or analogy to the objects signified. Of this nature was the method of writing practised among the Peruvians; who made use of small cords, of different colours, and by knots upon these, of various sizes, and differently arranged, contrived signs for giving information, and communicating their thoughts to one another. Of this nature, also, are the written characters which are used to this day in China. The Chinese have no alphabet of letters, or simple sounds, which compose their words; but every single character which they use in writing is significant of an idea: it is a mark which stands for some one thing or object, and consequently the number of these characters must be immense. This CHINESE writing, (which see,) probably began, like the Egyptian, with pictures and hieroglyphical figures; which figures being, in their progress, abbreviated in form, for the sake of more easily writing them, and greatly enlarged in number, passed at length into those marks or characters which they now use, and which have spread themselves through several nations of the East. For it is said, that the Japanese, the Tonquinese, and the Corocans, who
speak

Speak different languages from one another, and from the inhabitants of China, use the same written characters with them, and thus intelligibly correspond with each other in writing, though ignorant of the language spoken in their several countries. Our European arithmetical figures are significant marks, precisely of the same nature with the Chinese characters. Thus far nothing has appeared which resembles our letters, or which can be called writing, in the sense now given to that term. What we have hitherto seen were all direct signs for things, and made no use of the medium of sound or words; either signs by representation, as the Mexican pictures; or signs by analogy, as the Egyptian hieroglyphics; or signs by institution, as the Peruvian knots, the Chinese characters, and the Arabian cyphers. At length, in different nations, men became sensible of the imperfection, the ambiguity, and the tediousness of each of these methods of communication with one another, and began to consider the advantage resulting from employing signs, which should stand not directly for things, but for the words which they used in speech for naming these things; and they also considered, that though the number of words in every language be very great, yet the number of articulate sounds, used in composing these words, is comparatively small. Hence they were led to invent signs, not for each word by itself, but for each of those simple sounds that are employed in forming words; and they observed, that by joining together a few of those signs, it would be practicable to express, in writing, the whole combination of sounds which our words require.

The first step in this new progress was the invention of an alphabet of syllables, which probably preceded the invention of an alphabet of letters, among some of the ancient nations; and which is said to be retained, to this day, in Ethiopia, and some countries of India. By fixing upon a particular mark or character for every syllable in the language, the number of characters, necessary to be used in writing, was reduced within a much smaller compass than the number of words in the language. Still, however, the number of characters was great; and must have continued to render both reading and writing very laborious arts. At last some happy genius arose; and tracing the sounds made by the human voice to their most simple elements, reduced them to a very few vowels and consonants; and, by affixing to each of these the signs which we now call letters, taught men how, by their combinations, to put into writing all the different words, or combinations of sound, which they employed in speech. By being reduced to this simplicity, the art of writing was brought to its highest state of perfection, and in this state, we now enjoy it in all the countries of Europe.

To whom we are indebted for this admirable and useful discovery does not appear. There seems reason to conclude, from the books which Moses has written, that, among the Jews, and probably among the Egyptians, letters had been invented prior to his age. The universal tradition among the ancients is, that they were first imported into Greece by Cadmus the Phœnician, who, according to the common system of chronology, was contemporary with Joshua; but according to sir Isaac Newton's system, contemporary with king David. As the Phœnicians are not known to have been the inventors of any art or science, though, by means of their extensive commerce, they propagated the discoveries made by other nations, the most probable and natural account of the origin of alphabetical characters is, that they took rise in Egypt, the first civilized kingdom of which we have any authentic accounts, and the great source of art and polity

among the ancients. In that country, the favourite study of hieroglyphical characters had directed much attention to the art of writing. Their hieroglyphics are known to have been intermixed with abbreviated symbols, and arbitrary marks; whence, at last, they caught the idea of contriving marks, not for things merely, but for sounds. Accordingly, Plato (in Phædro) expressly attributes the invention of letters to Theuth or Thoth, the Egyptian, who is supposed to have been the Hermes, or Mercury, of the Greeks. Cadmus himself, though he passed from Phœnicia to Greece, as several of the ancients have affirmed, was originally of Thebes in Egypt. Most probably Moses carried with him the Egyptian letters into the land of Canaan; and there, being adopted by the Phœnicians who inhabited that part of the country, they were transmitted into Greece.

It is curious to observe, that the letters which we use at this day, can be traced back to the alphabet of Cadmus. The Roman alphabet, which obtains with us and most of the European nations, is plainly formed on the Greek, with a few variations. And all learned men observe, that the Greek characters, especially according to the manner in which they are formed in the oldest inscriptions, have a remarkable conformity with the Hebrew or Samaritan characters, which, it is agreed, are the same with the Phœnician, or the alphabet of Cadmus. If the Greek characters are inverted from left to right, according to the Phœnician and Hebrew manner of writing, they will appear to be nearly the same. Beside the conformity of figure, the names or denominations of the letters, alpha, beta, gamma, &c. and the order in which they are arranged, in all the several alphabets, Phœnician, Hebrew, Greek, and Roman, agree so much, as to amount to a demonstration that they were all originally derived from the same source. The letters were, at first, written from the right-hand to the left; and this manner of writing obtained among the Assyrians, Phœnicians, Arabians, and Hebrews: and from some very old inscriptions, it appears to have obtained also among the Greeks. Afterwards the Greeks adopted the method of writing their lines alternately from the right to the left, and from the left to the right, called *boustrophedon*. At length, however, the motion from the left-hand to the right being found more natural and commodious, the practice of writing, in this direction, prevailed throughout all the countries of Europe. See more on this subject under ALPHABET, CHARACTERS, and LETTERS.

Writing was long a kind of engraving. Pillars, and tables of stone, were first employed, and afterwards, plates of the softer metals, such as lead: but as writing became more common, lighter and more portable substances were employed. The leaves, and the bark of certain trees, were used in some countries; and in others, tablets of wood, covered with a thin coat of soft wax, on which the impression was made with a stylus of iron. See BOOK, BARK, and STYLE.

In later times, the hides of animals, properly prepared and polished into parchment, were the most common materials: our present method of writing on paper is an invention of no greater antiquity than the fourteenth century.

The advantages of writing above SPEECH (which see) are, that writing is both a more extensive and a more permanent method of communication: nevertheless, spoken language has a great superiority over written language, in point of energy or force. See Warburton, *ubi supra*. Blair's Lectures on Rhetoric, &c. vol. i. lect. 7.

An ingenious and learned writer has lately discussed the subject of this article in a very elaborate manner. He observes, that there is a difference, deserving particular attention in the inquiry, concerning the origin and progress of writing, between the imitative characters and symbolic or arbitrary marks. The former derive their origin from that imitative faculty, which is so conspicuous in the human species; the latter are founded in necessity or convenience, and become significant by compact: the one comprehends symbols and marks for sounds, significant of ideas; and the other have an immediate reference to sensible objects which present themselves to sight, and are applicable to hieroglyphical representations. Accordingly all representations, marks, or characters, which were ever used by any nation or people, must have been either imitative or symbolic.

This writer controverts the opinion of M. Fourmont, bishop Warburton, and M. Gebelin, who have endeavoured to shew, that alphabets were originally formed of hieroglyphical characters; alleging that the letters of an alphabet were essentially different from the characteristic marks deduced from hieroglyphics, which are marks for things and ideas, like the ancient and modern characters of the Chinese; whereas the former are only marks for sounds; and that, though there be a sufficient resemblance between the Mexican picture-writing, the Egyptian hieroglyphics, and the Chinese characters, yet these are foreign to alphabetic letters, and, in reality, do not bear the least relation to them. The hieroglyphic characters of the Chinese are, it is said, in their nature imitative, and do not combine into words, like arbitrary marks for sounds or letters, which are very few, and of a symbolic nature.

Letters, it is maintained, do not derive their powers from their forms, but originally their forms entirely depended on the fancy or will of those who made them.

Many learned men have supposed, that the alphabet was of divine origin; and several writers have asserted, that letters were first communicated to Moses by God himself; whilst others have contended, that the Decalogue was the first alphabetic writing. But if this art had been a new discovery in the time of Moses, he would probably have commemorated it; nor is there any reason to suppose, that God was the immediate revealer of the art, for Moses could never have omitted to have recorded the history of so important a circumstance, as the memory of it would have been one of the strongest barriers against idolatry.

It appears, however, that the art of writing is of great antiquity, and that the ancients, who ascribed the invention of it to the gods, had very imperfect ideas of its true origin. When it is considered that letters must have been the produce of a certain degree of civilization among mankind, the inquirers into their original have been naturally led to seek it in the history of those nations that appear to have been first civilized. Accordingly, many authors have decided in favour of the Egyptians. See LETTERS.

Others have vindicated the claim of the Phœnicians to the invention of letters; urging the testimony of Sanchoniatho, the most ancient and also the most celebrated Phœnician historian, corroborated by Pliny, Curtius, Lucan, Eusebius, &c. as well as their very early and high degree of civilization. The Chaldeans have also had several learned advocates, who have attributed the invention of letters to the patriarch Abraham: and sir Isaac

Newton, in particular, admits, that letters were known in the Abrahamic line for some centuries before Moses.

It is needless to mention the claims of the Tuscans, Indians, and Arabians. Mr. Aistle, *ubi infra*, declares in favour of the Phœnicians; and observes, that as the Chaldeans, Syrians, Phœnicians, and Egyptians, all bordered upon each other, and as the Phœnicians were the greatest as well as the most ancient commercial nation, it is very probable that they communicated letters to the Egyptians; the ports of Tyre and Sidon, and those of the Egyptians, being not far distant from each other. This author adds, that before the time when Mizraim went into Egypt, in the year before Christ 2188, and 160 years after the flood, Taaut, his son, had invented letters in Phœnicia; and if this invention took place ten years before the migration of his father into Egypt, as Mr. Jackson supposes, we can trace letters as far back as the year 2178 before Christ, and 150 after the deluge recorded by Moses: and beyond this period, the written annals of mankind, which have been hitherto transmitted to us, will not enable us to trace the knowledge of them, though this want of materials is no proof that letters were not known until a century and a half after the Deluge.

An opinion seems to be gaining credit among the learned, that arts and letters took their rise in the northern parts of Asia, and that they were cultivated in those parts, long before they were practised in Phœnicia or Egypt. Some travelled southwards, others staid behind; and those who afterwards emigrated from the East were generally called Scythians, and sometimes Huns, who overspread the northern parts of Europe. Many settlements were made in Germany long before the Christian era.

It has been asserted by many writers, that all alphabets are derived from one; but Mr. Aistle maintains, that there are various alphabets used in different parts of Asia, which differ from the Phœnician, ancient Hebrew, or Samaritan, in name, number, figure, order, and power. In several of these alphabets, there are marks for sounds peculiar to the language of the East, which are not necessary to be employed in the notation of the languages of Europe.

The following alphabets, says this learned writer, seem to be immediately derived from the Phœnician; *viz.* the ancient Hebrew, or Samaritan; the Chaldaic; the Bactrian, or that of the colony of Phœnicians or Canaanites, who are said to have fled from Joshua, and to have settled themselves, in the most early ages, in that part of Spain now called Andalusia and Grenada; the Punic, Carthaginian, or Sicilian; the Pelasgian Greek, and its derivatives, which are written in the Eastern manner, from right to left; and the Ionic Greek, written from left to right. This last-mentioned branch from the Pelasgic stock is the source from whence not only most of the alphabets of Europe are derived, but also of many others which have been adopted in different parts of Asia and Africa. From the Ionic Greek are derived the Arcadian, the Latin or Roman, the ancient Gaulish, the ancient Spanish, the ancient Gothic, the Coptic, the Russian, the Illyrian or Sclavonian, the Bulgarian, and the Armenian: the Runic is immediately derived from the Gothic.

The alphabets derived from the Roman are, the Lombardic, the Visigothic, the Saxon, the Gallican, the Franco-Gallic or Merovingian, the German, the Caroline, the Capetian, and the Modern Gothic. The first relates to the MSS. of Italy; the second, to those of Spain; the third, to the MSS. of Great Britain; the fourth and fifth,

to those of France; the sixth, to Germany; the seventh, eighth, and ninth, to all the countries of Europe where Latin is read. The six former alphabets are before the age of Charlemagne; the three latter follow it. The characters of these are more distinguished by their names than by their forms, which indicate that they are all of Roman extraction. The Lombardic, introduced into Italy by the Lombards in 569, was used by the popes in their bulls, and sometimes called Roman in the eleventh century: it ceased in the thirteenth century. The Visigothic, or Spanish Gothic, was introduced into Spain by the Goths or Visigoths; it was abolished in a provincial synod, held at Leon in 1091, when the Latin letters were established for all public instruments; though these characters were occasionally used in private transactions for upwards of three centuries afterwards. Saxon writing admits of various distinctions, *viz.* the Anglo-Saxon, Britanno-Saxon, and Dano-Saxon. The Gauls, on being subdued by the Romans, adopted their mode of writing; and by additions of their own, gave rise to the Gallican or Roman Gallic. The Franks, a people of Germany, having conquered part of Gaul, introduced their characters called Franco-Gallic, or Merovingian, because this kind of writing was practised under the kings of the Merovingian race. It took place about the close of the sixth century, and prevailed till the beginning of the ninth. The Caroline was derived from the improvement of Charlemagne; this declined in the twelfth century, and totally disappeared in the thirteenth, when it was succeeded in Germany by the Modern Gothic. The Caroline writing was restored by Hugh Capet about the year 987, and called Capetian: it was much practised till about the middle of the twelfth century; but in the thirteenth it degenerated into the Modern Gothic. The Capetian writing was used in England and in Germany, as well as France, during the above-mentioned period. The Modern Gothic, which spread itself over Europe in the twelfth and thirteenth centuries, is improperly so called; because it does not derive its origin from the writing anciently used by the Goths and Visigoths in Italy and Spain, but it is the most barbarous kind of writing: it took its rise in the decline of the arts among the lazy schoolmen, who had the worst taste; it is nothing more than the Latin writing degenerated. It began in the twelfth century, and was generally used (especially by monks and schoolmen) in all parts of Europe, till the restoration of the arts in the fifteenth century, and longer in Germany and the northern nations. Our statute-books are still printed in Gothic letters.

The learned are not agreed with respect to the origin of what is called *national* writing. Some will have it, that the Roman manner prevailed throughout the West, until the irruption of the barbarous nations of the North, in the fifth and sixth centuries: the Goths, they say, first introduced their mode of writing into Italy, instead of the Roman manner; the Visigoths did the like in Spain; the Franks in Gaul; the Saxons in England; and the Lombards in Italy.

According to others, the Romans were in possession of various forms of writing; but it is supposed, that the barbarous nations introduced some of their own letters in the writings composed of capitals and small letters; that the running-hand, peculiar to each nation, was used in grants and contracts, and found admittance likewise in manuscripts after the middle of the seventh century.

Mr. Aftle, however, is of opinion, that the different

modes of writing in Italy, Spain, France, England, and Germany, were derived from the Roman alone.

While Rome continued the centre of all the provinces of the empire, her manner of writing generally prevailed in each; but the empire being dismembered, and all the western provinces disunited, a change was produced; the conquerors disfigured the Roman writing, and by their false taste and ignorance, distinguished their writing from that of their neighbours: the genius and disposition of the different people having no small share in producing this diversity.

This notion greatly assists in discovering the age of manuscripts; for if a writing is Merovingian, it cannot be subsequent to the ninth, nor prior to the fifth century; if another is Lombardic, it must be posterior to the middle of the sixth, and anterior to the thirteenth; if Saxon, it cannot be earlier than the seventh, nor later than about the middle of the twelfth.

With regard to the forms of letters, many authors are of opinion that they are derived from the positions of the organs of speech in their pronunciation. Accordingly, M. Van Helmont hath taken great pains to prove, that the Chaldaic characters are the genuine alphabet of nature, because, he says, no letter can be rightly founded, without disposing the organs of speech into an uniform position with the figure of each letter.

Mr. Nelme published a work, in which he endeavours to shew that all elementary characters or letters derive their form from the line and the circle. Mr. Gebelin deduces them from hieroglyphic representations, and he hath given several delineations of human figures, trees, &c. in confirmation of his hypothesis. Mr. Aftle observes, that as letters are only marks for sounds, their forms entirely depended upon the taste, fancy, will, or caprice, of those who first formed them. In this point of view, they may be considered as arbitrary marks, or secret cyphers, which, by being made known and adopted, would become of general use, wherever they were received by agreement. For the number and forms of the letters of various alphabets, illustrated by figures, we must refer to Mr. Aftle's account, *ubi infra*.

After the most diligent inquiry, it doth not appear, says Mr. Aftle, that the Britons had the use of letters before their intercourse with the Romans: and though, from the coming of Julius Cæsar till the time when the Romans left the island in the year 427, the Roman letters were familiar to the eyes of the inhabitants, he is of opinion, that writing was very little practised by the Britons till after the coming of St. Augustine, about the year 596.

The writing which prevailed in England from this time to the middle of the eleventh century, is generally termed Saxon, and may be divided into five kinds; *viz.* the Roman Saxon, which is very similar to the Roman, and prevailed in England from the coming of St. Augustine till the eighth century; the set Saxon, which took place toward the middle of the eighth century, continued till about the middle of the ninth, and was not entirely disused till the beginning of the tenth century; the running-hand Saxon, which came into use towards the latter end of the ninth century, when learning was diffused in England under the auspices of king Alfred, in whose reign many books were written in this island, in a more expeditious manner than formerly; the mixed Saxon, occurring in the ninth, tenth, and in the beginning of the eleventh centuries, in many MSS., which were written in England in characters partly Roman, partly Lombardic, and partly Saxon; and the elegant

elegant Saxon, which took place in England early in the tenth century, lasted till the Norman Conquest, but was not entirely diffused till the middle of the twelfth, and is more beautiful than the writing in France, Italy, and Germany, during the same period.

The writing introduced into England by William I. is usually called Norman, and is composed of letters nearly Lombardic, which were generally used in grants, charters, public instruments, and law proceedings, with very little variation, from the Norman Conquest till the reign of king Edward III.

About the reign of king Richard II. variations took place in writing records and law proceedings; the charters from the reign of king Richard II. to that of king Henry VIII. were composed partly of characters called set chancery and common chancery, and some of the letters called court-hand; which three different species of writing are derived partly from the Norman and partly from the modern Gothic. The modern Gothic began to take place in England in the twelfth century; the old English about the middle of the fourteenth century; and set chancery and common chancery in the decline of the same century, and are still used in the enrolments of letters patent, charters, &c. and in exemplifications of recoveries: the court-hand was contrived by the English lawyers, and took its rise about the middle of the sixteenth century, and continued till the beginning of the late reign, when it was abolished by law. The court-hand characters were nothing more than the Norman characters very much corrupted and deformed.

In the sixteenth century, the English lawyers engrossed their conveyances and legal instruments in characters called secretary, which are still in use.

The French call their writing by the names of the different races of their kings, in whose time they were written: these were, the Merovingian, the Carolingian, the Capetian, the Valésian, and the Bourbonian.

The writing called Merovingian began in France soon after the time of Merovæus, son of Pharamond; who was made king A.D. 460: this race ends with Childeric, who died in 752. The Caroline race properly began with Pepin, who was made king of France upon the death of Childeric. This prince was succeeded by Charlemagne, A.D. 814, whose line in France ended with Lewis V. A.D. 987. The Capetian race began with Hugh Capet, who succeeded Lewis V., and ended with Charles IV. A.D. 1327. The Valésian race began with Philip IV. the successor of Charles IV., and ended with Henry III. the last of this line, who was slain in 1589. The Bourbonian line began with Henry IV. A.D. 1589, whose descendants now fill the throne of France.

The MSS. written in the northern parts of Scotland and in Ireland are in characters similar to the Saxon. The learned and ingenious colonel Vallancey thinks, indeed, that the Iberians, who migrated from the borders of the Euxine and Caspian seas, and settled in Spain, learned letters and arts from the Phœnicians: that a colony of the ancient Spaniards, by the name of Scots or Scythians, settled in Ireland about a thousand, or perhaps six hundred years before Christ, and that they brought elementary characters with them into Ireland. He observes, that the Irish alphabet differs from that of all other nations, in name, order, number, and power, and supposes, that they might have received their alphabet from the Carthaginians, who also settled a colony in Ireland about six hundred years before Christ; and adds, that this opinion is the more to be credited, as the Irish language appears to have a radical identity with the Punic.

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In order to discover what real pretensions the Irish have to the early use of letters, for which they eagerly contend, Mr. Astle has examined their stone monuments, their coins, and their MSS., and appealed to the historians of that country. The letters upon the most ancient of their monuments are apparently of Roman and Roman-British original; and none of these inscribed monuments are so ancient as to prove that the Irish were possessed of letters before the Romans had intercourse with the Britons; though they prove that they had letters before the arrival of St. Patrick in that kingdom, which, Mr. Whitaker, with great probability of truth, says, were waisted over from the Caledonians, who used the Roman letters. Sir James Ware says, that the Irish alphabet was borrowed from the British, and that the Saxon characters were nearly the same as the Irish; and adds, that Mr. Camden inclined to this opinion.

Moreover, there are no Irish coins, inscribed with letters, till long after the twelfth century: except coins struck by some of our Saxon kings, who made incursions into that country, and struck money there in the Saxon manner.

The oldest Irish MS. which has been discovered is the Psalter of Cashel, written in the latter end of the tenth century.

The testimony of approved historians is likewise unfavourable to the ancient literature of Ireland. Mr. Innes, in his Essay on the Antiquities of Scotland and Ireland, and Mr. James Macpherfon, in the third edition of his Introduction to the History of Great Britain and Ireland, maintain, that Ireland was first peopled from Britain; and that the manners of the old Irish were inconsistent with the knowledge of letters.

It seems probable, that the interior parts of Europe were immediately peopled from the northern parts of Asia, and the maritime parts from Phœnicia, and the southern and western parts of that quarter of the globe. If this be the case, it is not surprising that some Eastern customs prevailed in Great Britain and Ireland, and that many Celtic words are still preserved both in the Irish and in the Welsh languages.

The Norman characters, it is observed, were generally used in England from the coming of William I., and the Saxon characters were entirely diffused in the very beginning of the twelfth century; but the Irish and Scots preserved the ancient forms of their characters till the end of the sixteenth century.

The Gaëlic or Erse language, used in the Highlands of Scotland, and the Ibero-Gaëlic, are nearly the same, and their letters are similar to each other, as Mr. Astle has shewn by various specimens. The curious will find much information on the subject of this article in Astle's Origin and Progress of Writing, 4to. 1784.

J. Ravenau has a treatise, intitled "Des Inscriptions en Faux," in which he shews how to revive and restore old writings almost effaced, by means of galls ground in white wine and distilled, and thus rubbed over the writings.

To write without blacking the fingers: prepare the paper with a fine powder, made of three parts of calcined copersas, two of galls, and one of gum arabic; those being fresh mixed, rub them with a hare's foot into the pores of the paper, and then write with fair water, and the black letters will immediately appear.

To make new writing appear old, moisten it with oil of tartar *per deliquium*, more or less diluted with water, as you desire the ink to appear more or less decayed.

We may write without ink or its materials; for this purpose, take a fine powder of calcined hartshorn, of clean tobacco-pipes, or rather of mutton-bones burnt to a perfect

whiteness, and rub it upon the paper, and then write with a silver bodkin, or the like. Boyle's Works abr. vol. i. p. 114, 115. See **INK**.

The discharging of ink out of parchment, paper, &c. is commonly done by aqua fortis diluted sufficiently with water, that it may not destroy the paper. The like may be done with oil, or spirit of vitriol diluted. The juice of lemons, or strong vinegar, will take ink out of linen more safely, as the mineral acids are apt to destroy the linen, unless great care be used in diluting them.

We may write on iron with corrosive sublimate wetted with common water: for this purpose, the parts of metal we would preserve untouched should be covered with wax, and that taken off in the proper places to make way for the corroding substance. Boyle, *ib.* p. 528.

The like may be practised by means of aqua fortis.

Mr. Boyle mentions a method he had of copying a whole page of writing at once. But we do not find his description of it any where. *Ib.* p. 136.

A machine has been lately invented and constructed by Messrs. Watt and Co. of Birmingham; by means of which letters and other writings may be copied. For an account of the structure and use of this machine, we must refer to the directions for copying with it, furnished by the inventors; observing, however, that the date, at which a writing will yield a copy, is extremely uncertain, from the weather, as it is more or less drying, and from the state of the ink. In general the purpose will be answered to the end of twenty-four hours, and sometimes of three or four days; but it is most advisable to copy letters as soon after they are written as may prove convenient. See **COPYING**.

Mr. Boyle informs us of a method of imitating writing on copper-plates. The copy to be engraved is to be wrote with a peculiar kind of ink, and the copper-plate being moderately warmed is rubbed over with a white varnish, and suffered to cool; then the paper being gently moistened, that it may readily communicate its ink, the writing is applied to the prepared surface of the plate, and passed through a rolling-press; by which means, the ink adhering to the varnish leaves the letters very conspicuous. And hence it is easy with a needle to trace the strokes through the varnish upon the plate, which being afterwards cleaned, the letters are finished with the graver, and the work printed off in a rolling-press, as common cuts.

Mr. Boyle does not mention what the varnish or ink, used by the artificer from whom he received this method, was; but he tells us, that he himself used the purer sort of virgin wax for a varnish; and for his ink he took fine Frankfort black, carefully ground with water, till it obtained the consistence of common ink; but no gum was added, lest it should hinder the ink from coming off. He also observes, that written characters may be taken off without the help of a press, by laying the moistened paper smooth upon the varnished copper, and rubbing it on hard with a convex piece of glass. See **SYMPATHETIC INK**.

In law, we say, deeds, conveyances, &c. are to be in writing. A will may either be in writing, or by word of mouth.

We also say, *written law, lex scripta*, in opposition to common law, which is called *lex non scripta*. We have also *written and unwritten traditions, &c.*

Authentic writings of any contract, sealed and delivered, make the evidences thereof.

La Vayer has a curious dissertation on the proof of facts by comparison of hand-writings, in which he endeavours to shew this method of proof to be very suspicious and fallacious.

WRITING, Gothic. See **GOTHIC**.

WRITING, Secret. See **CRYPTOGRAPHY, STEGANOGRAPHY, SCYTALA, CIPHER, DECIPHERING, &c.**

WRITING, Short. See **BRACHYGRAPHY, STENOGRAPHY, and TACHYGRAPHY.**

WRITINGS, Stealing of. See **LARCENY.**

WRITTEN EVIDENCE. See **EVIDENCE.**

WRITTEN Tradition. See **TRADITION.**

WRITZEN, in *Geography*, a town of the Middle Mark of Brandenburg, on a branch of the Oder; 18 miles N.W. of Custrin.

WRONG, in a *Logical Sense*. See **ERROR, FALSEHOOD, and TRUTH.**

WRONG, in a *Legal Sense*, *injury, tort*. See **INJURY, and TORT.**

Wrongs are divisible into two sorts, *viz. private and public*. The former are an infringement or privation of the private or civil rights belonging to individuals, considered as such; and are frequently termed *civil injuries*. The latter are a breach and violation of public rights and duties, which affect the whole community, considered as such; and are distinguished by the harsher appellation of *crimes and misdemeanours*.

WRONG, Executor of his own. See **EXECUTOR de son Tort.**

WRONG-Lands, in our *Old Writers*, seem to denote trees that will never prove timber; such as wrong the ground they grow in.

WRONGS, in *Agriculture*, a term applied to the crooked arms or large boughs of trees, when the fagot-wood is cut off from them.

WROTHAM, in *Geography*, a market-town in the upper half hundred of the same name, in the lathe of Aylesford, and county of Kent, England, is situated near the base of some chalk-hills, at the distance of 10 miles W.N.W. from Maidstone, and 24 miles S.E. by E. from London. The manor was granted by king Ethelstan, in the year 964, to the priory of Christ-church, Canterbury. On the division of the possessions of the monks by Lanfranc, it was allotted to the archbishops of Canterbury, who had a palace and frequently resided here, till the time of archbishop Islip, who pulled down the buildings for the sake of the materials, which he applied to the completion of the palace at Maidstone, which his predecessor, John Ufford, had begun. Archbishop Cranmer resigned the manor to Henry VIII., and it was granted by Edward VI. to sir John Mason, who disposed of it to the Byngs, ancestors of the lords Torrington, of whom it was purchased by William James, esq. of Ightham, whose descendants still possess it. Wrotham church, the only public edifice in the town, is a spacious well-built structure, and consists of a nave, aisles, chancel, and transept, with an embattled tower at the west end; the chancel is light and elegant. The sepulchral memorials are numerous; among which are several curious brasses, recording the family of Peckham, who were resident in this parish during several centuries. The Rayner family, who resided at Wrotham-Place the whole of the 17th century, have also monuments here. The rectory is esteemed one of the best livings in Kent. Of the ancient archiepiscopal palace little now remains but a gateway, and a substantial stone building which formed part of the offices. The population return of the year 1811 states the town to contain 107 houses, and 613 inhabitants. Here is an annual fair, and a weekly market on Tuesday. The parish is very extensive, comprehending the villages of Hale, Nepicar, Plaxted, Winfield, and Roughway. In a park within the limits of the parish is a capital mansion, once the seat of sir Harry

Harry Vane, who on the restoration of Charles II. suffered death for the part he took against Charles I. This estate, on the death of lord viscount Vane in 1789, became the property of David Papillion, esq.: it is now occupied by the earl of Delawar.—*Beauties of England and Wales*, vol. viii. Kent, by E. W. Brayley, 1807.

WROTZKO, a town of Prussia, in the palatinate of Culm; 12 miles S.W. of Strasburg.

WROUGHT, in *Ship-Building*, a term applied to any piece of timber, &c. when it is trimmed and fitted for its situation.

WROXETER, in *Geography*, a village of England, in the county of Salop, at the union of the Torn and the Severn, by Antoninus called "Uriconium," by Ptolemy "Viriconium," by the Welsh and Britons "Caer Vruach," and by the Saxons "Wrekenceaster." It was the chief city of the Cornavii, and founded by the Romans, when they fortified the bank of the Severn where fordable. It was encompassed by a rampart and ditch; the walls were three yards thick, and were three miles in circumference. After suffering much in the Saxon wars, it was quite ruined by the Danish, and is now but a small place. Many Roman coins and other antiquities have been found here; 5 miles S.E. of Shrewsbury, and 155 N.W. of London.

WRUNG-HEADS, a former name given to the bilge of a ship, &c. or that part near the floor-heads, which, when a ship lies aground, bears the greatest strain.

WRY-NECK, (*Caput obliquum, cervix obliqua, torticollis*,) denotes that deformity of the human body, in which the neck is bent laterally, generally inclining at the same time somewhat forwards, so that the head is also drawn to one side and forwards, being indeed frequently quite approximated to the shoulder. For the most part, the neck is in this case altogether irregularly formed: on the side towards which the head inclines, it seems exceedingly plump, the strong shortened muscles being bulky, and affected with considerable spasm; while, on the other hand, the opposite side, where the neck is convex, exhibits no such strong rigid muscles, or at all events so little of this appearance, that, notwithstanding its convex form, it seems obviously less fleshy. When the disease has continued a long while, and attained a serious degree, its effects extend also to the head itself. On that side where the irregular action of the muscles is strongest, and where consequently the head is most drawn downwards, the half of the face is usually more or less contracted, and weaker than the opposite half, the zygomaticus major, the buccinator, the masseter, and other muscles, being considerably less prominent. This disfigurement of the countenance has a very unpleasant appearance, and plainly indicates the distorted position into which the head is drawn. The patients are also incapable of turning their heads properly, or of directing their faces upwards; and if these functions can be executed in a very imperfect way, it is not without a good deal of effort, which in general the patients prefer avoiding. Hence they mostly choose to remain in their distorted posture, and instead of trying to turn their heads with the muscles of the neck alone, they prefer accomplishing this object rather by turning the whole body. Hence an opportunity is given for the evil to increase in a very rapid and afflicting degree. According to the observations of Richter and Bernstein, the face is commonly turned towards the opposite side, and only now and then towards that to which the head inclines. (*Anfangsgr. der Wundarzneykunst* 4ter. Band, 2te. Auflage, f. 256. *Practischen Handbuche für Wundärzte*, &c. Neue Auflage, 3ter. Theil, f. 215.) Professor Jörg of Leipzig does not

exactly coincide with these surgeons on this particular point; but we think that the difference is merely in terms, and not in the thing itself, Richter meaning that the face is turned towards the sound side, not that it is drawn away, and made more distant from the shoulder to which the whole neck and head incline. Professor Jörg takes a review of the action and insertions of the sterno-cleido-mastoideus muscle, which proceeds down the neck from the mastoid process, and splits into two portions; one of which is inserted into the external and anterior part of the clavicle, the other into the upper and outer surface of the sternum. The clavicular portion of this muscle must necessarily tend to draw the head towards the clavicle, which is the fixed point, while the sternal portion will pull it towards the breast; but both acting together, will draw it in a diagonal line. At the same time that they have the effect of inclining the head forwards and to one side, they impart to the neck the same direction, and even slightly turn it, so that the nose is no longer situated in a straight line directly over the sternum, but is placed to one side of such a line. When, for example, says professor Jörg, the right sterno-cleido-mastoideus is too short, and is therefore the cause of the wry-neck, it will pull the head towards the right side, and also forwards, in such a manner that the nose is moved to the left of a line drawn upwards from the sternum, and the neck itself is at the same time slightly turned. But when this is the case, the whole face must obviously be somewhat turned towards the left side, and drawn a little way downwards and forwards. When, however, the whole head is drawn forwards, laterally, (in this case to the right,) and at the same time downwards, consequently the face forwards, laterally, (in this case to the left,) and downwards, it cannot be said that the face is moved in a different direction from that of the rest of the head. Although the face is turned in a different direction, still it is not inclined towards the opposite side; for, says professor Jörg, if this were so, the neck must be much more turned than actually happens. Hence, he thinks, that a case has really never existed, where the face and head have been inclined in different directions.

With respect to the causes of this infirmity, they are, according to several writers, very numerous, and it is not to be denied that they may be of different kinds. Yet, says Jörg, "I have never seen the complaint originate in the bones: the muscles were always the parts first concerned. According to my observations, the sterno-cleido-mastoideus must be looked upon as being the chief original cause of this deformity, which I have never seen unattended with the particular and manifest influence of that muscle. When also several other muscles gradually participate in the disorder, the sterno-cleido-mastoideus is usually the first affected. While it is more disposed to an irregular action than any other muscle of the neck, its greater strength makes it in some measure govern the rest." As children, both in the erect and horizontal postures, frequently keep their necks unevenly, and more to one side than the other, professor Jörg conceives that this will account for one sterno-cleido-mastoideus readily becoming shorter than its fellow; the equilibrium ceases, and a wry-neck is immediately produced. Young children often contract a habit of lying in bed constantly upon the same side, whereby the muscles of the neck become gradually habituated to an irregular kind of tension, which by degrees breaks the antagonizing power between the opposite sets of muscles. The same thing happens, when children are constantly carried with their head upon one and the same side of their nurse. But this irregularity in the muscles in question is also frequently

quently congenital, and then we need not specify any occasional causes. The evil, though it exists at the time of birth only in a trivial degree, afterwards quickly increases, and soon becomes serious. The regular equilibrium between the sterno-cleido-mastoidei may likewise be destroyed, when one of them is wounded, or completely cut through; when it remains preternaturally weak, in consequence of having been the seat of abscesses, and previous ulceration; or when, from any cause whatsoever, its action is rendered either too feeble or too powerful.

In one patient cured by professor Jörg, it is alleged that the inner portion of the left sterno-cleido-mastoideus was inserted into the middle and right side of the sternum, in the same place as the inner portion of the muscle of this name on the right; and the above author conceived, that this preternatural attachment was probably the cause of the inclination of the head to the right side.

Professor Jörg does not give much credit to the opinion, that the wry-neck is frequently brought on by a contraction of the skin of the neck and of the platysma myoides; the first of these parts being very yielding, and the second very thin and elastic. But, he thinks, that when these parts, or any other muscles of the neck, are shortened and spasmodically contracted, it is generally as a consequence of the affection of the sterno-cleido-mastoideus, which is the part originally disordered.

The same writer will not deny also, that the malformation of the bones may be the first cause of this infirmity. If, says he, the dorsal and lumbar vertebræ are liable to curvature, why should the cervical ones not be so, and thereby destroy the equilibrium between the muscles of the neck? Yet, he thinks, the cause of the disorder must lie much more rarely in the bones than the muscles, since he has never seen one instance of it. He admits also, that there can be no doubt that the bones sooner or later share in the effects of the disease; that they become bent to one side, and even cemented together by ankylosis.

As in every other disorder, the practitioner must endeavour to find out the original cause of the complaint; and, therefore, the question arises, how can it be known whether the muscles and the integuments, or the bones, are the first cause of the deformity? The cause may be ascribed to the muscles, when there is obviously something wrong about them; when they are hard and contracted on one side, and soft and little prominent on the other; and when those which are shrunk and shortened become still harder and more painful, on putting the head in a straight position, to the doing of which they also make more or less resistance. We may be more certain of the thing, when no disease of the bones in any part of the body, and no causes of such complaint, can be detected; for when the bones are about to soften, or are already softened, the latter affection must be preceded by certain occasional causes, and accompanied with the usual symptoms. The discovery of these, according to professor Jörg, is not difficult to the practitioner, at least not impossible. The disorder, on the other hand, may be referred to the bones, when no particular defect about the muscles is apparent, when they are no where remarkably hard and contracted, and when the case is attended with symptoms and vestiges of a partial or general softening of the bones. When this is the case, the muscles are usually much less altered than when they constitute the original cause of the deformity; and the head can be more easily raised, turned, and moved about.

Another question is, what degree has the disorder already attained, and have the bones materially participated in the affection or not? Perhaps the cervical vertebræ are

ankylosed? Although it may at first seem easy to answer these questions, yet it is not always so easy. The prognosis and treatment, however, are to be regulated by the decision; and we can never speak satisfactorily of the case, unless we have inquired into the whole of its progress.

When the bones are affected, that is to say, when in consequence of the wrong posture of the neck a change has taken place in their form; when they, as is most usual, on the side towards which the head is inclined, are lower than on the other; or when their processes are diminished or absorbed; the practitioner can frequently feel and see that the defect lies in the texture of the bones. The depressions thus produced may sometimes be plainly seen, or, at all events, can be felt with the finger. When the head and neck are put into the right position, these depressions become still more obvious, as well as the alteration of the spinous processes. In order to derive from such examination any precise knowledge, we must indeed be well acquainted with the anatomy of the neck. Professor Jörg then gives us some directions how to move the head and neck, and how to place our fingers in trying to ascertain whether the cervical vertebræ are ankylosed. We pass these over, because we place very little confidence in their accuracy or utility.

The professor next notices the influence which the deformity has over the whole organization of the body. An imperfection in the formation of the head is the first and principal effect derived from the infirmity. In cases of wry-neck, he has never seen the face and head altogether well constructed. The half of the face which was nearest to the contracted sterno-cleido-mastoideus was always smaller, and less prominent, than the other. Frequently the lower jaw, the zygoma, and the eye, were more sunk on this side than the other, and hence the countenance presented a very distorted emaciated appearance. The foregoing author has also constantly found the raising of the head, and other motions of this part, materially prevented. The patients always stoop to one side in a most awkward kind of posture. None of them can turn their heads well. Whenever they want to look laterally, they are obliged to turn their whole bodies. Hence many of them become disqualified for certain occupations, and even if they are capable of work, they labour with more difficulty than other persons. The preternatural dragging downward of the head, and the curvature of the cervical vertebræ, one would think (says professor Jörg) would have a bad effect on the functions of the brain and spinal marrow. He has, however, never seen this happen; but on the contrary, in the worst forms of the complaint, he has not found the brain at all affected. Still he does not venture to conclude that things are always so. Our limits oblige us to pass over some other remarks on the preceding topic, in order to begin the consideration of the method of treatment.

We find then that the wry-neck mostly arises from an affection of the muscles, and especially from irregular action in the sterno-cleido-mastoidei, the equilibrium between which is destroyed: hence the treatment is generally directed against the muscles, particularly those above-mentioned. It is seldom that it is necessary to do any thing for the bones. For this reason, the prognosis is generally favourable, and this the more so the younger the patient is, and the more yielding the contracted sterno-cleido-mastoideus happens to be found. Indeed, when the patient is farther advanced in life, and not more than twenty-five or thirty years of age, we should not totally despair of being able to render assistance, if no ankylosis exist, and not too much deformity of the cervical vertebræ. What kind of a prog-

rosis can be made, when the bones are originally concerned in the production of a wry-neck, must depend upon the nature and degree of the morbid affection of those parts.

In the treatment of a wry-neck, we must endeavour to soften and relax the contracted muscles, and strengthen those which are stretched and tense. The first indication, Jörg thinks, may be fulfilled by the use of oily emollient liniments two or three times a day; the second by the employment of spirituous stimulating embrocations. When common applications of the last kind are unavailing, we are advised to use spirit of ammonia, tincture of cantharides, &c. It is also necessary to persevere for a long time in these remedies, even though the skin may become red and tender. Jörg is an advocate likewise for applying compresses to the parts dipped in such stimulating fluids, and kept constantly wet with them. Thus he calculates on maintaining the effects of their operation without interruption.

If the complaint be considerable in degree, and the head and neck much distorted, we are advised to combine with the foregoing means what are termed *manipulations*, which consist in manual endeavours to obtain an elongation of the contracted muscles, especially the sterno-cleido-mastoideus. In these manœuvres, we are directed to rub with one hand the muscle upwards, and at the same time to try to move the head in the same direction. With the other hand we are to bring the head into its natural position, and keep it there, so that the contracted muscles may be extended as much as possible. The greater their spasmodic contraction is, the more must we rub them in the direction above specified, even as long as a quarter or half an hour at a time; and the plan must be repeated once, twice, or thrice a day, until the head will remain quite straight, or until that side of the neck, which was previously convex, has become concave, and *vice versa*. Besides these *manipulations*, the head and face should be moved together into a perfectly upright posture, laterally, and especially towards the side to which they could not be turned, owing to the contracted state of the muscles. By these means, the patient will soon acquire the faculty of moving the neck to one side, which must always be a desideratum in the treatment.

Professor Jörg says, he has not deemed it necessary to mention electricity and galvanism as remedies, which may be joined with those above recommended. Whoever likes to try them, however, should only apply them to those muscles which are in a state of tension; for every stimulus must be improper for such as are contracted.

This author does not say much in favour of the warm bath as a remedy for wry-necks, in which cases he owns he has never made trial of it. All his patients have been children from one to nine years of age; and he thinks it would have been difficult, and even dangerous in some circumstances, to have immersed them sufficiently in the warm water to cover their necks. These are the only reasons which he gives for not having tried so important a remedy for the wry-neck as the warm bath.

One of the principal means for the cure of a wry-neck consists in a mechanical apparatus, by which the head is brought into a straight position, the contracted muscles are elongated, and others, which are on the stretch, kept in a state of rest and relaxation. It may be said, indeed, that the patient should be able to put his head and neck in this posture himself, and that no mechanical apparatus is requisite. But such posture can only be adopted by making a great effort, and even then imperfectly. Hence the best inclined patients soon give up the attempt, and the head

becomes depressed again. For children who cannot be persuaded to observe regularly the desirable position, the apparatus is more essential than for many adults. Several other writers had entertained this opinion previously to professor Jörg. Köhlers, Bernstein, and other authors, recommend a variety of mechanical contrivances for the cure of the wry-neck. None of these, however, have answered the expectations of professor Jörg, who has felt himself called upon to make an invention of his own. In the construction of his machine, he went upon the following principles: 1. That its operation should be effected by means of a spring. 2. That the action of the stretched enfeebled sterno-cleido-mastoideus should be strengthened, and the equilibrium between it and its fellow thereby re-established.

The apparatus consists of a leather pair of stays, and of a band or fillet which goes round the head. On the centre of the fore-part of the stays is a kind of pulley, or wheel, which admits of being turned to the right or left, and then becomes fixed by means of a spring. From this apparatus a band proceeds up the patient's neck to the fillet, placed round the head, and to which it is fastened directly behind the ear, close to the mastoid process. This band lies in the same direction as the lengthened sterno-cleido-mastoideus muscle, and when drawn towards the breast by the wheel, it produces the same effect as would arise from an increase of strength in the action of that muscle. In short, it pulls the mastoid process downwards and forwards towards the sternum, counteracts the influence of the opposite muscle of the same name, and thus rectifies the position of the head.

But this band, says professor Jörg, does not merely draw down the side of the head which is too elevated, it also tends to put the neck in a straight position. It was above explained, that a wry-neck is always more or less twisted, in consequence of the contraction of one of the sterno-cleido-mastoidei, and thus the mouth does not lie in a direct line perpendicularly above the centre of the sternum, but to one side of this point. The action of the preceding band, by drawing forwards as well as downwards towards the middle of the breast, the mastoid process evidently tends to counteract the effect produced by the wrong action of the faulty muscle of the opposite side.

Professor Jörg makes his patients wear the apparatus day and night, and he does not even take it off when the frictions are made. The band is to be tightened and regulated according to the effects produced. Particular care, however, must be taken not to make it too tight at first.

When by perseverance in the use of this apparatus, and the other means above recommended, the neck has been put into a proper position again, it usually happens that the head itself continues inclined too much forward; an effect which the contracted sterno-cleido-mastoideus, and its antagonist the band, both tend to promote. Something, therefore, must be done for the alleviation of this deformity. With this view, Jörg removes the above band from the breast, carries it under the arm, and through a ring at the side of the leather stays or corsets, and thence to the fillet round the head, where it is fastened in the same place as before. In this manner, the head will be considerably elevated, while still the object of counteracting the shortened sterno-cleido-mastoideus of the opposite side is not neglected. The ring hinders the band from hurting the axilla, and keeps it from following the motions of the shoulder. The preceding author lets his patients, towards the latter part of the treatment, wear the apparatus in this way a long while; yet sometimes he applies it in both modes alternately, with
a design

a design of habituating the muscles of the head and neck to different postures.

Together with this treatment, professor Jörg enjoins attention to every thing which tends to improve the health, especially a proper nourishing diet, pure air, &c. One thing he insists upon as essential, *viz.* that during work or repose, sleeping or awake, the patient constantly keep the head and neck in the right position. Hence children must be most vigilantly observed, as they soon forget what is told them; and the posture in which they lie when asleep must be attended to, as it is frequently a bad one. Jörg recommends laying their heads on firm round bolsters filled with horse-hair, and placing them on the side on which the muscles are contracted. The bed should be flat, and not sink, in order that the shoulder may not be depressed. In this position, the head will be pressed and inclined towards the opposite side. The patients must also be forbidden to do any kind of labour which will oblige them to hold their heads in a hurtful position; but Jörg rather commends dancing and the military exercise, as accustoming the patient to hold his head as he ought to do.

When the bones are concerned, the above apparatus and treatment will not be effectual; and particular machinery adapted to the case must be employed.

Frequently the curative means are prematurely discontinued, and the disorder recurs. It is commonly imagined, that when the head and neck can be brought straight, every thing is accomplished. But, as Jörg remarks, it is wrong to consider this period the completion of the cure; for, when the head and neck can be kept every day several hours in a right posture, without any machinery, the convalescents soon become fatigued, as it cannot be at first done without exertion. It is only when both sterno-cleido-mastoidei seem to be formed alike; when one is not tender than the other; and when, consequently, the equilibrium betwixt them is re-established; when also one side of the neck is as prominent and well-formed as the other; and when the head can be brought into the right position naturally, and without any effort; that the cure ought to be regarded as accomplished. The machinery may now be gradually relinquished with safety. At first it is to be taken off for an hour at a time every day, and the period of its discontinuance is to be lengthened by degrees, until at length it is entirely laid aside. For the foregoing excellent observations we are indebted to professor Jörg of Leipzig, whose publication on the deformities of the human body is entitled in German "Ueber die Verkümmungen des Menschlichen Körpers und eine rationelle und sichere Heilart derselben." Leipzig, 1816, 4to.

This author has not mentioned or given any opinion respecting the plan which was proposed by Mr. Sharp, of dividing and even cutting out a portion of the sterno-cleido-mastoideus muscle, which appears to act with too much power.

Mr. Gooch cured a patient by merely dividing the skin and platysma myoides muscle; a kind of case which Jörg thinks infrequent. Mr. Gooch also sometimes employed machinery with success.

WRY-NECK, a disease of the spasmodic kind in sheep, in which the head is drawn forcibly to one side, and the animal disabled from walking. The cure is to be effected by the use of calomel with opium in pretty full doses; putting the animal into a dry well-grassed pasture during the time, and avoiding cold and moisture.

WRY-NECK, *Jynx*, in *Ornithology*, a bird called also the *torquilla*, which Linnæus has made a distinct genus of the *picæ*, under the denomination of *yunn*: the characters of

which are, that the bill is slender, round, and pointed; the nostrils are concave and naked; the tongue is very long, very slender, cylindric, and terminated by a hard point; and the feet are formed for climbing.

There is only one species, *viz.* the *jynx torquilla*. The colours of this bird are elegantly pencilled, though its plumage is marked with the plainest kinds: a list of black and ferruginous strokes divides the top of the head and back; the sides of the head and neck are ash-coloured, beautifully traversed with fine lines of black and reddish-brown; the quill-feathers are dusky, but each web is marked with rust-coloured spots; the chin and breast are of a light yellowish-brown, adorned with sharp-pointed bars of black; the tail consists of ten feathers, broad at their ends and weak, of a pale ash-colour, powdered with black and red, and marked with four equidistant bars of black: the irides are of a yellowish colour.

The wry-neck, Mr. Pennant apprehends, is a bird of passage, appearing with us in the spring before the cuckoo. Its note is like that of the kestrel, a quick-repeated squeak: its eggs are white, with a very thin shell; this bird builds in the hollows of trees, making its nest of dry grass. It has a very whimsical way of turning and twisting its neck about, and bringing its head over its shoulders, whence it had its name *torquilla*, and its English one of wry-neck: it has also the faculty of erecting the feathers of the head like those of the jay. It feeds on ants, which it very dexterously transfixes with the bony and sharp end of its tongue, and then draws them into its mouth. Ray and Pennant.

WRYNOSE, in *Geography*, a mountain of England, on which are three stones, marking the boundaries of the three counties of Lancaster, Cumberland, and Westmoreland; 12 miles S. of Ravenglass.

WSCHESTAD, a town of Bohemia, in the circle of Kaurzim; 10 miles N.W. of Kofeteletz.

WSETIN, a town of Moravia, in the circle of Hradisch; 23 miles N.E. of Hradisch.

WUIPENS. See WIPPINGEN.

WULDA, a town of Bohemia, in the circle of Bechin; 12 miles S.W. of Crumau.

WULFEN, a town of Westphalia, in the bishopric of Osnabruck; 8 miles E.N.E. of Osnabruck.

WULFENIA, in *Botany*, was so named by professor Jacquin, in honour of his highly deserving friend, and constant botanical correspondent, the Rev. Francis Xavier von Wulfen, professor of natural philosophy and mathematics at Klagenfurt, in Carniola, to which charge he was appointed in 1762, and where he died March 17, 1806, aged seventy-eight. Amid the duties of his professorship, and the more serious calls of his ecclesiastical station, which he fulfilled by the most exemplary and active benevolence and charity to all within his reach, his favourite pursuit was the study of the botany and mineralogy of the surrounding country. His numerous contributions to the publications of Jacquin, on the rare plants of Carniola and Carinthia, constitute a treasure of the most valuable and original information. He writes with the ardour of a real lover of nature, and we have nothing to disapprove, except somewhat of the diffuse, and what Linnæus terms "oratorical," style, in the descriptive parts of his writings, where terseness and precision are most desirable, however agreeable the graces of oratory, and the expression of taste and feeling, may be in any accompanying remarks. The *Flora Lapponica* of Linnæus is our standard of perfection in this respect. Wulfen was an accomplished scholar, a man of the most amiable and elevated character, who adorns every thing that he touches, and

and who lived and died beloved and revered by men of all ranks, and of every persuasion. As he lived remote from the scientific circles of Europe, it is no wonder if, in the abstruse study of cryptogamic botany, he fell into some errors, especially relative to the *Lichen* tribe, a part of which the writer of this article presumed to correct, in a paper printed in the Transactions of the Linn. Soc. v. 2. p. 10, certainly without intending any disrespect for the excellent author, though a German writer of a more vulgar stamp, by mis-translation and misrepresentation, tried to excite them to enmity, but in vain. He may be pardoned for the sake of the great man whom he, though unskilfully, meant to defend, and for his own services to science, though of inferior pretensions. Wulfen is reported to have left behind him in MS. a complete *Flora Norica*, descriptive of the vegetable productions of a particular part of Carniola, an *Agrotopographia*, and several other works, rich in practical and scientific observations. Of these, it is to be hoped the learned world will not be deprived.—Jacq. Misc. Austr. v. 2. 62. t. 8. f. 1. Schreb. Gen. 16. Willd. Sp. Pl. v. 1. 78. Vahl Enum. v. 1. 86. Mart. Mill. Dict. v. 4. Sm. Transf. of Linn. Soc. v. 6. 96. (Bonarota; Mich. Gen. 9. t. 15. Pæderota; Juss. 120. Lamarck Dict. v. 4. 692. Illustr. t. 13, but not the original *Pæderota* of Linnæus. See Tr. of Linn. Soc. as above.)—Class and order, *Dianthria Monogynia*. Nat. Ord. *Personata*, Linn. *Scrophularia*, Juss.

Gen. Ch. *Cal.* Perianth inferior, of one leaf, in five deep, linear-awlshaped, equal, erect, permanent segments. *Cor.* of one petal, ringent: tube gibbous, and nearly globose at the base: limb two-lipped; upper lip shortest, undivided, or slightly notched, vaulted, acute; lower longest, deflexed, three-lobed. *Stam.* Filaments two, thread-shaped, ascending, shorter than the upper lip; anthers roundish. *Pist.* Germen superior, ovate-oblong, compressed; style thread-shaped, twice as long as the calyx; stigma capitate. *Peric.* Capsule ovate, compressed, furrowed at each side, of two cells and two divided valves, bursting at the summit. *Seeds* numerous, roundish.

Ess. Ch. Corolla tubular, ringent; upper lip vaulted; lower three-cleft. Calyx in five deep segments. Capsule of two cells, and two cloven valves.

Obs. This genus is certainly next akin to *VERONICA*, under which article we have recorded a remark to that effect made by Mr. Brown. The essential difference, however, between these two genera resides in the limb of the *corolla*, which in *Veronica* is wheel-shaped, its lower segment narrowest; a character of more importance than the proportion of the tube, that part being, in a few species, nearly as much elongated as in the present genus. If any of those species should prove to have a ringent *corolla*, whose upper lip is vaulted, and the lower three-lobed, they must be removed to *Wulfenia*; but we discover nothing of this in *V. sibirica* or *virginica*, whose limb is truly that of a *Veronica*. Whether the throat be bearded in every species of *Wulfenia*, we are not certain; nor is that circumstance material, any more than the valves of the *capsule* being cloven or not, the same difference existing between different species of *Veronica*, as has already been mentioned in its proper place. The five-cleft *calyx*, indicated by Linnæus as the mark of *Pæderota*, is found in the two *Veronica* just named, as well as in some less ambiguous species, as *V. austriaca*, *multifida*, *Teucrium*, and *latifolia*, though in these last the fifth segment varies in size, is occasionally absent, and is always unequal to the others.

1. *W. Bonarota*. Blue Leafy Wulfenia. Sm. n. 1. Vahl n. 1. (*Pæderota Bonarota*; Linn. Sp. Pl. 20.

Willd. Sp. Pl. v. 1. 77. Jacq. Austr. append. t. 39. P. cærulea; Linn. Suppl. 84. Lamarck Illustr. v. 1. 48. t. 13. f. 1. Bonarota montana italica, chamædryos folio, flore cæruleo; Mich. Gen. 19. t. 15. f. 1; also f. 2, with rounder leaves, and a more dense spike. Chamædryos montis Sumani; Bauh. Hist. v. 3. 289.)—Stem leafy. Upper lip of the corolla entire. Leaves roundish-ovate.—Native of the mountains of Italy and Carniola; perennial: a stranger in our gardens, as well as the two following. The root is somewhat creeping. Stems simple, erect, five or six inches high, downy like the rest of the herbage, each bearing four or five pair of roundish-ovate leaves, about an inch long, with broad, rather shallow serratures. Cluster terminal, foliary, ovate-oblong, of several pretty blue flowers, accompanied by lanceolate bractæas. Calyx hairy. The corolla is decidedly ringent, with a concave upper lip, and the valves of the capsule split at the summit, each into two sharp points.

2. *W. Ageria*. Yellow Leafy Wulfenia. Sm. n. 2. Vahl n. 2. (*Pæderota Ageria*; Linn. Mant. 171, including Bauhin's synonym. Willd. Sp. Pl. v. 1. 77. P. lutea; Scop. Ann. 2. 41. Lamarck n. 3. excluding the reference to Bauhin. Linn. Suppl. 84. P. Bonarota; Jacq. Hort. Vind. v. 2. 55. t. 121. Bonarota montana italica, chamædryos folio minus crenato, spicâ luteâ; Mich. Gen. 19.)—Stem leafy. Upper lip of the corolla cloven. Leaves ovate-lanceolate, elongated at the point.—Native of Carniola and Italy, in places where, according to Scopoli, the former is not found. Great confusion respecting these two plants has long existed. Linnæus and Scopoli sometimes considered them as varieties of each other, and when they made them distinct, they misapplied their synonyms. The present is said to be distinguished by the emarginate, or cloven, upper lip of the corolla, which, nevertheless, Jacquin's figure does not express, and which is but slightly perceptible in our dried specimens. The leaves differ materially in their more elongated form, and narrower, more copious, serratures; the lower ones being alternate, as noticed by Scopoli, is but a casual occurrence. The corolla is of a pale sulphur-colour, not blue. Calyx smooth. The style in both these species is full as long in proportion to the calyx and corolla as in the following, though described, in the generic character of *Pæderota* by Linnæus, as only the length of the stamens.

The specific name of *Ageria*, given by Linnæus to what had much better have been called *lutea*, is intended to commemorate Nicholas Agerius, a friend of John and Caspar Bauhin, who sent our *W. Bonarota* to the former, and is mentioned by him in several places. His name occurs in Linn. Sp. Pl. 1670, as the original discoverer of *Verbascum Thapsi*. Haller speaks of him as having published, at Strasburg, in 1625, a quarto dissertation de *Zoophytis*; and another in 1629, de *Animâ vegetativâ*; works not mentioned in Sir Joseph Banks's rich catalogue, and therefore, doubtless, very rare.

3. *W. carinthiaca*. Carinthian Wulfenia. Sm. n. 3. Willd. n. 1. Vahl n. 3. Jacq. Misc. Austr. v. 2. 60. Ic. Rar. t. 2. (*Pæderota nudicaulis*; Lamarck Dict. v. 4. 692. Illustr. v. 1. 48. t. 13. f. 2.)—Stem naked. Leaves crenate.—Found by Wulfen, in a rich soil, among limestone rocks, on the loftiest and most craggy mountains of Carinthia, flowering in the middle of July. The root is creeping, perennial, half as thick as the middle finger. Leaves several together in a tuft, all radical, obovate, obtuse, four or five inches long, doubly or unequally crenate, smooth and shining, except the strong mid-rib, which is hairy at the back; their base tapering into a winged footstalk.

Flowers

Flowers large and handsome, of a fine blue, crowded numerously into a dense cluster, supported by an upright, round, firm, unbranched, leafless, though somewhat scaly and slightly hairy, solitary, radical *stalk*, twice or thrice the height of the leaves. After flowering, the *cluster* becomes three or four inches long, and the permanent *calyces* turn reddish. The *capsules* are each one-third of an inch in length, brown, abrupt, scarcely exceeding the calyx, soon splitting into four parts at the top. The error of the specific name in Lamarck's synonym, *P. Wulfenia*, for *P. nudicaulis*, in Vahl and Willdenow, is copied by the former from the latter.

WULFRADT, in *Geography*, a town of the duchy of Berg; 3 miles N.E. of Medman.

WULFSDORP, a town of the duchy of Holstein; 11 miles N.N.W. of Lubeck.

WULFSFELDE, a town of the duchy of Holstein; 12 miles N.W. of Lubeck.

WULFTEN, a town of Westphalia, in the bishopric of Osnabruck; 2 miles S.W. of Osnabruck.

WULLED, a town of Arabia, in the province of Yemen; 46 miles S.E. of Loheia.

WULLERSDORFF, a town of Austria; 2 miles S.E. of Gunderdorff.

WULLI, *Mountains of*, mountains of Persia, which extend from the vicinity of Shatzan, across to the lake of Vaikind, and form one range with that on the N. of Mekran, called Gehelabad by La Rochette.

WULPERODE, a town of Westphalia, in the principality of Halberstadt; 4 miles W. of Osterwick.

WULTZESHOFEN, a town of Austria; 1 mile S.W. of Laab.

WULVESHEVED, or WULVESHEAD. See WOLFESHEAD.

WUMBLE, in *Rural Economy*, the provincial name of an auger. It is sometimes written wummle and wimble.

WUMME, in *Geography*, a river of the duchy of Bremen, which runs into the Weser, about 6 miles N.W. of Bremen.

WUNALACHTIKOS, a tribe of Delaware Indians.

WUNNENBERG, a town of Westphalia, in the bishopric of Paderborn, which received its name from a victory which Charlemagne gained in the year 974 over the Saxons; 14 miles S. of Paderborn. N. lat. $51^{\circ} 29'$. E. long. $8^{\circ} 7'$.

WUNSCHELBERG, or HRADECK, a town of Silesia, in the county of Glatz. Here are manufactures of thread, cloth, and variety of stuffs; 10 miles N.W. of Glatz. N. lat. $50^{\circ} 19'$. E. long. $16^{\circ} 15'$.

WUNSCHUECH, a town of Stiria; 8 miles S. of Gratz.

WUNSEES, a town of Germany, in the principality of Bayreuth; 13 miles W. of Bayreuth.

WUNSIEDEL, a town of Germany, in the principality of Bayreuth, on the Fichtelberg; near it are mines of copper and iron, and quarries of marble; 34 miles E. of Bayreuth. N. lat. $50^{\circ} 3'$. E. long. $12^{\circ} 3'$.

WUNSTORF, a town of Westphalia, in the principality of Calenberg, the chief place of a county, which became extinct in the year 1533; 10 miles W.N.W. of Hanover. N. lat. $52^{\circ} 27'$. E. long. $9^{\circ} 32'$.

WUNT, in *Agriculture*, a term provincially applied to the mole.

WUNT-Hillock, a word signifying a mole-hill. See MOLE and MOLE-Hill.

WUNTZ, in *Geography*, a town of the county of Henneberg; 6 miles N.W. of Meinungen.

WURBEN, a town of Silesia, in the principality of Schweidnitz; 4 miles N. of Schweidnitz.

WURBENTHAL, a town of Silesia, in the principality of Troppau; 13 miles W. of Jajerndorf. N. lat. $49^{\circ} 57'$. E. long. $17^{\circ} 15'$.

WURFE, in *Commerce*, a denomination distinguishing a certain quantity of inferior silver coins in Germany; thus, a wurfe denotes 5 pieces of 17 or of 7 creutzers; and 12 wurfe of 17 creutzer pieces make 17 florins, and 12 wurfe of 7 creutzer pieces make 7 florins.

WURGLAU, or GUERGALA, in *Geography*. See WERGELA.

WURL, a river of Westphalia, which runs into the Ems, near Rietberg.

WURLITZHAI DT, a town of Germany, in the principality of Culmbach; 7 miles S.E. of Hof.

WURMBEA, in *Botany*, is dedicated by Thunberg to the honour of baron Frederick van Wurmb, secretary to the Academy of Sciences at Batavia, whom he celebrates for great skill in Natural History, and other scientific pursuits, and who rendered him important services in his expedition to Japan.—Thunb. Nov. Gen. 18. t. 1. Schreb. Gen. 239. Willd. Sp. Pl. v. 2. 265. Mart. Mill. Dict. v. 4. Ait. Hort. Kew. v. 2. 325. Poir. in Lamarck Dict. v. 8. 802. Lamarck Illustr. t. 270. (Melanthii species; Juss. 47. Thunb. Prodr. 67.)—Class and order, *Hexandria Trigynia*. Nat. Ord. *Coronaria*, Linn. *Junci*, Juss.

Gen. Ch. *Cal.* none; unless, like Thunberg, we take the corolla for such. *Cor.* of one petal, tubular, permanent: tube with six angles, abrupt at the base: limb in six deep, lanceolate, acute, equal, erect, or spreading segments, usually about the length of the tube. *Stam.* Filaments six, thread-shaped, erect, inserted into the mouth of the tube, and shorter than the limb; anthers roundish, of two lobes. *Pist.* Germen superior, triangular, furrowed, smooth; styles three, awl-shaped, triangular, the length of the filaments; stigmas obtuse. *Peric.* Capsule invested with the withered corolla, oblong, with three angles and three furrows, consisting of three cells, separating from the top half way down. *Seeds* numerous, round.

Ess. Ch. Calyx none. Corolla in six deep equal segments, with an hexagonal tube. Stamens inserted into the mouth of the tube. Capsule superior.

Obs. Under the genus MELANTHIUM, (see that article,) we have expressed a determination of reducing the present genus to that. By a casual oversight, however, the species which compose *Wurmbea* were there omitted. Having examined them with more attention, and particularly with respect to ORNITHOGLOSSUM, which the reader will find in its proper place, our opinion has changed. The latter genus, to which *Melanthium indicum* perhaps really belongs, has most resemblance to *Wurmbea* in habit, and in the general aspect of the *flowers*; though most widely estranged therefrom in its generic character, founded on the insertion of the *stamens*. If *Ornithoglossum* be retained, *Wurmbea* must. No difficulty attends its essential character, which is obvious enough, in the pale hexangular tube, abrupt or gibbous at the base, as if furnished with six small spurs. The Linnæan herbarium shews, that Linnæus himself had established the present genus, and dedicated it to his friend Sparrmann, by whom his specimens were brought to Europe. There is a singular remark in Thunberg, of *Wurmbea* having, "without all doubt," been produced from *Melanthium ciliatum*!

1. *W. pumila*. Dwarf *Wurmbea*. Willd. n. 1. (*W. capensis* α ; Thunb. Nov. Gen. 19. t. 1. f. 7.)—Cluster of three

three or four flowers. Tube the length of the limb.—Native of the Cape of Good Hope, in sandy ground, at the foot of small hills, flowering in August or September. The *root* is a small globular bulb, as in all the rest, sunk deep into the earth. Whole *herb* but an inch high, with two or three short, sheathing, lanceolate *leaves*. *Cluster* hardly rising above the foliage, of three or four, rarely more, erect white *flowers*, on longish partial stalks, not sessile, or spiked, if Thunberg's figure be correct, like the other species. The margins of the segments of the *flower* are purple, and there are spots of the same colour just above the mouth of its tube. The *stamens* are white. *Thunberg*.

2. *W. campanulata*. Bell-flowered Wurmbea. Willd. n. 2. Ait. n. 2. (*W. capensis* γ; Thunb. Nov. Gen. 19. t. 1. f. β. Lamarck f. 1. *Melanthium monopetalum*; Linn. Suppl. 213. Ker in Curt. Mag. t. 1291.)—Tube of the corolla bell-shaped, the length of the limb, which is twice as long as the stamens. Spike dense, cylindrical.—Native of the same country. Sent to Kew garden, by Mr. Masson, in 1788. It flowers in the green-house in May and June. The *bulb* is ovate. *Stem* solitary, simple, leafy, from three to five inches high; zigzag, tapering, and pale, in the part which is below the surface of the ground. *Leaves* three or four, alternate, widely spreading, or recurved, much longer than the stem, but not elevated above it, tapering, channelled, rather glaucous, smooth; their base dilated and sheathing. *Spike* terminal, erect, two or three inches long, of numerous, sessile, white *flowers*, whose limb is rather concave, its edges brown in our specimens, answering to Thunberg's description, though that circumstance is not expressed in the Botanical Magazine. *Stamens* white, spreading, not half the length of the limb, with yellow *anthers*.

3. *W. purpurea*. Purple Wurmbea. Banks MSS. Ait. n. 2. (*W. capensis* β; Thunb. Nov. Gen. 19. Andr. Repos. t. 221. *W. campanulata* β; Willd. n. 2. *Melanthium spicatum*; Curt. Mag. t. 694.)—Tube of the corolla much shorter than the widely spreading limb.—Native of the Cape. Sent to Kew in 1788, by Mr. Masson. This has the herbage of the last, but the *spike* is rather more lax, and the *flowers* all over of a dark violet purple, except the yellow *anthers*, have a much shorter *tube*, and longer *limb*.

4. *W. longiflora*. Long-flowered Wurmbea. Willd. n. 3. (*W. capensis* δ; Thunb. Nov. Gen. 19. t. 1. f. α. Lamarck f. 2.)—Spike taller than the leaves. Tube of the corolla twice the length of the limb.—Found at the Cape of Good Hope, on sandy hills in various places. A taller larger plant than any of the preceding; its *leaves* much broader at the base. *Spike* three or four inches long, rather lax, many-flowered, with a zigzag angular *stalk*. *Flowers* entirely white; their *tube* near an inch long; *limb* about half that length, widely spreading. *Stamens* full half the length of the limb. That all these species should have been considered as varieties only, appears as strange as any other particular in the history of the present genus. The Linnæan herbarium proves the *Melanthium monopetalum* of the Supplementum to be not this, but the *W. campanulata*.

WURMBERG, in *Geography*, a town of the duchy of Stiria; 6 miles N.W. of Pettau.

WURMSEE, a lake of Bavaria; 13 miles S.W. of Munich.

WURST, a Russian measure. See WERST.

WURSUREE, in *Geography*, a town of Hindoostan, in Guzerat; 32 miles N.E. of Chitpour.

WURTEMBERG, late a duchy and now a kingdom of Germany, bounded on the north by the bishopric of

Spire, the palatinate of the Rhine, the county of Hohenlohe, and territories of the city of Hall in Swabia; on the east by the county of Limburg, the territories of the imperial towns Gemund and Ulm, and county of Oettingen; on the south by Austrian Swabia, the territories of Furstenberg, Zwifalten, Rothweil, and the Brigau; and on the west by the marquisates of Baden Baden, and Baden Durlach: about 64 miles from north to south, and about as much from east to west, comprehending about 3200 square miles. This kingdom consists of a great number of counties and lordships, some of which were purchased, some devolved to it by marriage, and others were acquired by conquest. It is beyond dispute the most considerable and fertile part of the circle of Swabia, and may indeed be said to be, after Saxony, one of the best countries in all Germany. From its natural disposition, the country consists of three tracts, which are all remarkably different. Of these, the lowest and warmest is the north, called Unterland, reaching from Heilbronn to Stuttgart. This duchy abounds so in grain, that it exports considerable quantities; but this grain is chiefly spelt, rye and wheat being much less cultivated here. Of all the other sorts of grain, however, here is also a sufficiency, even for export. Flax and hemp are also cultivated, and the former of these thrives best in the cold parts. The valleys, some of which are seven or eight miles in length, are covered as it were with forests of fruit-trees, of which there is no scarcity in the other parts of this country, cyder and perry being the liquors drank in common by the country people, when wine happens to be dear. This duchy abounds likewise in very rich, palatable, and wholesome wines, called by the general name of Neckar wines, though each has a particular title of its own, which it receives from the parts where it grows. The grapes also, which yield the best wines, bear the appellation of the countries whence the sets were first brought, as the Chiavenna, Valteline, Tyrolese, and Hungarian. The vineyards of the duchy of Wurtemberg have been greatly improved by shoots from France, Italy, Greece, Hungary, Cyprus, and even Schiras in Persia. The cultivation of silk was revived under duke Charles. The forests of this country are considerably lessened. The consumption of oak, in particular, has been very large. The mountains of the Black forest on the W. and those of the Alt on the S. and E., not only diversify the face of the country, but supply timber, food, and wines. Most parts of the country abound in game; near Frudenstadt, and near Konigswart, are mines of silver and copper; of silver at Konigstein, and of copper at Guttach: near Hornberg iron is also found. Of minerals, *terra sigillata*, which is reckoned preferable to that of Malta, and a fine clay for earthenware, as also porcelain, which is worked at Calv; fine variegated marbles, some of which are equal to those of Italy; and remarkably transparent alabaster, agate, crystalline pebbles, black amber, or rather obsidian, fine mill-stones, &c.: and at Sulz there are salt-works. Among the baths in Wurtemberg, the most celebrated is that of the Wildbad. The principal rivers are, the Neckar, the Enz, and the Nagold. The number of inhabitants in this state is known to precision, an exact inquiry being made every year by the general superintendants, and reported to the annual synod; they are now about 600,000. The state contains 68 cities and towns, with about 1200 boroughs, market-towns, villages, and hamlets. The revenue is computed at 245,000*l.*, and the military force at 6000. The established religion of this country is Lutheranism, and though duke Charles Alexander embraced the Roman, yet in the years 1729, 1732, and 1733, he gave assurances to the states, in formal instru-

ments, that no change or innovation should be made in the Lutheran religion in any part of the whole duchy, and that in all the churches and schools throughout the duchy, and the countries thereto belonging, no other religion than that of Lutheranism should be taught: that no Catholic churches, chapels, altars, or images, should be erected or set up, nor any such as were decayed or forsaken again used. The Calvinists only are tolerated here, and their place of worship at Stuttgard is a private house. In this duchy are also some Waldenses, who are either husbandmen or farmers, and live in the Italian villages, as they are called, some few towns alone excepted; where they have established manufactures of hats and stockings, and are allowed the public exercise of their religion. The toleration of the Jews here was abolished by an edict of duke Christopher, that of two or three families at Stuttgard excepted, under the particular protection of the court. The church is governed by four superintendants, styled abbots, and 38 rural deans; a synod is annually held in the autumn. Education, and particularly that of ecclesiastics, is favoured by laudable institutions; the seminary of Tubingen used to accommodate about 300 students; and at Stuttgard there is a public academy. Here are manufactures of pottery, glass, woollen, linen, and silk, which, with the natural products of the country, supply a considerable export. The imports are by Frankfort on the Maine. The chief city is Stuttgard, and the second town is Tubingen. The other towns are numerous, but small; and the villages are thickly placed in a populous and flourishing country. The origin of the princely house is somewhat obscure and uncertain. It is certain, however, that there were counts of Wurtemberg at the beginning of the twelfth century. In 1802 Wurtemberg was created an electorate of the empire; and in 1806 was erected into a kingdom. The castle of Wurtemberg, which gave name to the duchy, is situated 4 miles E. from Stuttgard. By the treaty of Presburg in 1805, the king of Wurtemberg acquired several important reserves.

WURZBURG, a town of Germany, in the county of Erbach; 3 miles E. of Erbach.

WURTZEN, a mountain of Carinthia; 8 miles S. of Villach.

WURWAMA, a town of Hindooستان, in Guzerat, on the south side of the gulf of Cutch; 40 miles N.E. of Noanagur.

WURWAY, a river of North Wales, which runs into the Vurney, 3 miles S. of Llanvilling, in the county of Montgomery.

WURZACH, a town of Germany, in the county of Waldburg, on the Aitrach; 26 miles N.W. of Kempten. N. lat. 48° 0'. E. long. 9° 52'.

WURZBACH, a river of Germany, which runs into the Klein Enz, 2 miles E. of Wildbad.

WURZBURG, a duchy, late a bishopric, bounded on the north by the county of Henneberg and principality of Coburg; on the east by the bishopric of Bamberg, the margravate of Anspach, and the county of Castell; on the south by the county of Hohenlohe; and on the west by Mergentheim, county of Wertheim, electorate of Mentz, and the bishopric of Fulda; about 80 miles in length, and 64 in breadth. The territory of Wurzburg is fertile in corn, pastures, and divers sorts of fruits and plants, as also in wine, the very best Franconian vines growing in it. The prevailing religion is the Roman Catholic; but there are also Lutheran and Calvinist churches within the ecclesiastical jurisdiction and territory of Wurzburg, which from time to time preferred to the diets of the empire grievous complaints of oppression and injustice. In the

sixteenth century, this bishopric abounded with Protestant inhabitants. The bishopric was not founded here till 741. In the year 1752, pope Benedict XIV. granted them the privileges of bearing the archiepiscopal pall and crosses; but in other respects they were suffragans to the archbishops of Mentz. This prince and bishop maintained five regiments of foot and horse, military affairs being subject to the aulic council of war. In 1806 Wurzburg was secularized, soon after erected into a duchy, and given to the archduke Ferdinand. The number of inhabitants is computed at 200,000. By the treaty of Presburg in 1805, the new kingdom of Bavaria, to which Wurzburg had been before assigned, acquired several important additions.

WURZBURG, a city of Germany, and capital of a duchy, late residence of the bishop. It is situated on the Maine, well fortified, and defended by a fortress, situated on a rock without the town; in which fortress is an episcopal palace, and a church, supposed to be the oldest in Franconia. The town is divided into four quarters and four suburbs, in which are, a new palace, built in the beginning of the eighteenth century, a cathedral, several collegiate and parish churches, colleges, abbeys, and convents. The university was founded in the year 1403; and, after falling to decay, restored again in 1582. In August 1796, Wurzburg was taken by the French, but given up to the Austrians the month following; 50 miles E.S.E. of Frankfort on the Maine. N. lat. 49° 50'. E. long. 9° 59'.

WURZELBAU, or WURTZELBAU, JOHN PHILIP, in *Biography*, a German astronomer, was born at Nuremberg in 1651, and being diverted from his studies by a change of circumstances, devoted himself to mercantile pursuits. But in the midst of these occupations, he reserved his spare hours for reading, and acquainting himself with the French, Italian, and Spanish languages. His chief attention was directed to mathematics and astronomy. In 1684 and 1685 he made observations on an eclipse of the moon, which were printed; and in 1689 transmitted to the Royal Society communications pertaining to astronomy. In 1691 devoting himself more sedulously to the study of geometry and astronomy, the emperor Leopold, apprized of his merits, raised him and his heirs to the rank of nobility in 1692. In 1699 he was chosen one of the foreign associates of the Academy of Sciences at Paris, and in 1706 he became a member of the Academy of Berlin. Declining a removal to Dresden, with the offer of an annual salary of 1000 dollars and free lodging, he occupied himself in astronomical observations with instruments of his own invention and construction; and he built, at his residence in Nuremberg, an observatory consisting of an octagon turret, covered with copper, and resting on iron bars, which was placed on the top of the house, and which was moveable to every part of the heavens: it was furnished with an azimuth quadrant of five feet radius, a sextant of six feet, and other instruments; of which observatory he published an account at Nuremberg, 1697, fol. He published also other works, *ibid.* 1713, fol. and *ibid.* 1719, fol. Having published solar tables, &c. he died at Nuremberg in 1725. He published also various observations in the *Phil. Trans.* vol. xv. xvi. xvii. and vol. xxx.; and also at Nuremberg. Montucla. Weidler. *Gen. Biog.*

WURTZEN, or WURTZEN, in *Geography*, a town of Saxony, in the territory of Leipzig; the bailiwick of which extends over seventy-six villages, and twenty-two noble estates; anciently the see of a bishop, but in 1661, the estates of the foundation were annexed to the Leipzig circle. The town is situated on the Mulda; though not large in itself, it is much increased by its fauxbourgs, which contain

the citadel and cathedral. The beer brewed here is the chief article of trade, and is exported in great quantities; 14 miles E. of Leipzig. N. lat. $51^{\circ} 19'$. E. long. $12^{\circ} 42'$.

WUSEN, a town of Prussia, in the province of Ermland, on the Passarg; 25 miles W. of Heilsberg.

WUSHUTEE, or MEECH, a general term applied to all that country of the province of Mekran in Persia, lying to the westward, and on the parallel of Punjgoor or Panger, and forming the northern boundary of the Sandy Desert. It is represented to be a mountainous district, producing in some of its villages grain, sufficient for the consumption of the few wandering shepherds who inhabit them. Water is plentiful, except in April, May, and June; dates are also produced, and camels, sheep, and goats, are procurable, but not in great number. The people are rather a small delicate race: their arms are, a match-lock, sword, and shield; and each village has its own chief, who settles disputes that arise among the inhabitants.

WUSLACH, a town of Prussia, in the province of Ermland; 10 miles E. of Heilsberg.

WUSTENSAXEN, a town of Germany, in the principality of Wurzburg; 5 miles N. of Bischofsheim.

WUSTERHAUSEN, a town of the Middle Mark of Brandenburg; 11 miles S.S.E. of Berlin.—Also, a town of the Middle Mark of Brandenburg, on the Dosse; 36 miles N.W. of Berlin. N. lat. $52^{\circ} 53'$. E. long. $12^{\circ} 31'$.

WUSTERSDORF, a town of Austria; 9 miles S.W. of Laab.

WUSTHAL, a town of Germany, in the circle of the Lower Rhine; 4 miles N. of Rothenbach.

WUSTRO, a town of Westphalia, in the principality of Lunenburg Zelle, on the Jetze and the Dumme; 40 miles S.E. of Luneburg.

WUTACH, a river of Germany, which crosses the county of Stuhlingen, and runs into the Rhine, 10 miles below Lauffenburg.

WUTTOOR, a town of Hindoostan, in Dowlatabad; 6 miles E. of Junere.

WUTZKOW, a town of Hinder Pomerania: it is the last post stage bordering on Poland; 30 miles E. of Stolpe.

WYACONDA, a river of Louisiana, which runs into the Mississippi, N. lat. $39^{\circ} 46'$. W. long. $91^{\circ} 48'$.

WYALUSING, a township of Pennsylvania, in the county of Luzerne, with 576 inhabitants; 320 miles N. of Washington.

WYALUSING *Creek*, a river of Pennsylvania, which runs into the E. branch of the Susquehanna, N. lat. $41^{\circ} 40'$. W. long. $76^{\circ} 20'$.

WYANDOT, a town of North America, belonging to the United States: a tribe of Indians called Wyandots inhabit the neighbourhood; 6 miles S. of Sandusky.

WYASTON, a village in the hundred of Appletree, Derbyshire, England, situated 3 miles from Ashborne, and 137 from London. In the year 1811 it contained 16 houses, and 69 inhabitants.

WYAT, Sir THOMAS, in *Biography*, an English poet, was the son of Henry Wyatt, esq. of Allington-castle in Kent, and born in 1503. Having finished his education at Cambridge and Oxford, he travelled, as an envoy, into various parts of Europe, and acquired the favour of Henry VIII. whose good will was of very short duration; for either from a suspicion of his connection with Ann Boleyn, or the ill offices of Bonner, he was for some time imprisoned. After his liberation he retired to his castle of Allington, and being employed to conduct the ambassador of Charles V. from Falmouth to London he was seized with a fever, of which he died at Sherburn in 1541. In an elegy on his

death, his character was highly drawn in an encomium by the earl of Surrey, with whom he was intimate, as his fellow-labourer in polishing English poetry; though his strains are said to have been inferior to those of the earl of Surrey. Mr. Warton distinguishes him by the appellation of the first polished English satirist. His reputation was high, and Leland published a book of Latin verses on his death. His poems were printed with the editions of those of Surrey in 1559 and 1565, and since by Dr. Sewel, in 1717. His version of David's Psalms is much commended by Surrey and Leland; but it is not extant. Warton's Hist. of Eng. Poetry. Gen Biog.

WYBERTON, in *Geography*, a village and parish in the wapentake of Kirton, Holland division of the county of Lincoln; 2 miles from Boston, and 115 from London. It was returned in the year 1811 as containing 74 houses, occupied by 353 persons.

WYBOLDSTON, a village in the hundred of Barford, Bedfordshire, England, situated 8 miles from Biggleswade, and 2 miles from St. Neot's. The population is not separately returned, being included in the parish of Eaton-Socon.

WYBORG. See VIBORG.

WYBUNBURY, or WIBBUNBURY, a village in the hundred of Namptwich, county palatine of Chester, is situated on the borders of Staffordshire, about 3 miles E. from Namptwich. The church is a handsome structure, and contains a great variety of monuments and other sepulchral memorials. A school was built here nearly two centuries ago by subscription; the endowments are but small, though increased by occasional donations: the school is for boys, some of whom are taught reading only, others reading, writing, and arithmetic. The population return of the year 1811 states this village to contain 76 houses, and 353 inhabitants. The parish of Wybunbury is very extensive, and comprehends eighteen townships.—Lyttons's Magna Britannia, vol. ii. Cheshire, 1810.

WYCH-HOUSE, a house in which salt is boiled. (See SALT.) In the places where there are salt-springs, and salt-works are carried on at them, the work-house where the salt is made is always called the wych-house; and hence we may naturally conclude that *wych* was an old British word for salt, which is the more probable, as all the towns in which salt is made end in *wych*; as *Namptwyc*, *Droitwyc*, *Middlewyc*, &c.

WYCHERLEY, WILLIAM, in *Biography*, was born at Cleve, in Shropshire, about the year 1640; and in France, whither he went for his education, he conformed to the Roman Catholic religion. Upon his return to England a little while before the Restoration, he entered, without matriculation, as a gentleman-commoner at Queen's college, Oxford, and leaving it without a degree, took chambers in the Middle Temple. However, he abandoned the law, and addicted himself to the composition of comedies, the first of which was entitled "Love in a Wood, or St. James's Park," which brought him into notice in 1672; so that he became a favourite of the dukes of Cleveland, and of Villiers, the duke of Buckingham. He was also honoured by the attention of the king, and by promises of future promotion. His majesty, however, was displeased by his marriage with the countess of Drogheda, and the connection was unhappy. On occasion of her death, however, she settled her whole estate upon him, and his title being disputed, he was involved in law expences and other incumbrances, which occasioned his being committed to prison. Having remained in prison for seven years, he was liberated by king James II., who, delighted by seeing his comedy of

the "Plain Dealer," gave orders for the payment of his debts, and settled upon him a pension of 200*l.* a year.

His circumstances were still embarrassed, and though by his father's death he became a tenant of the estate to which he succeeded, he was not emancipated from his difficulties. Some time after he married a young woman, on whom he settled a jointure of 1500*l.*, humourously stipulating with her that she should not take an old man for her second husband, which condition, it is said, she promised faithfully to observe. He died in 1715, at the age of 75.

Besides the two comedies already mentioned, he composed "The Gentleman Dancing-Master," and "The Country-Wife." The last and the Plain Dealer are said to be the most noted. His plays, though commended by lord Rochester, are strongly marked with his own character,—“some wit and strength of delineation, with much coarseness and licentiousness.” He attacks vice, it is said, with the severity of a cynic, and the language of a libertine. A volume of poems published in 1704 was so unsuccessful, that he applied to Pope, who was a mere youth, to correct the versification. Dr. Johnson remarks, that “when Pope was sufficiently bold in his criticisms, and liberal in his alterations, the old scribbler was angry to see his pages defaced, and felt more pain from the detection than content from the amendment of his faults.” The posthumous works of Wycherley, in prose and verse, were published by Theobald in 1728, 8vo., but they are utterly forgotten. Biog. Brit. Johnson's Life of Pope. Gen. Biog.

WYCK, JOHN, was the son of Thomas Wyck, a painter of shipping and views of towns, of no very great celebrity, who was in England in the time of Charles II. John was born at Haerlem about the year 1640, and distinguished himself as a painter of battles and sieges, and sometimes of huntings and processions. He imitated the style of Wouvermans and Vander Meulen, but never obtained their neatness or finish, though his colour is oftentimes very agreeable. His execution is better upon a small than a larger scale. He died at Mortlake in 1702.

WYCK, in *Geography*, a part of the city of Maestricht, on the E. side of the Meuse, strongly fortified. See MAESTRICH. —Also, a small sea-port of Russia, on the W. coast of the island of Esel.

WYCK *op Zee*, a town of Holland, near the sea; 3 miles W. of Beverwick.

WYCK *te Duerstede*, a town of Holland, in the department of Utrecht, supposed to be mentioned by Tacitus, by the name of "Batavodurum," and said to have been built by Battus, prince of the Catti. It was granted, with its territory, to Rixfride, the seventh bishop of Utrecht, and his successors, for the zeal he had shewn in converting the infidels. Trithemius relates, that it was anciently three leagues in circumference, and had 55 parish-churches, and that it had been destroyed by the Normans and Danes three several times; 13 miles S.E. of Utrecht.

WYCLIFFE, a small village and parish in the wapentake of West Culling, North Riding of Yorkshire, England, is situated two miles N.E. from Greta-bridge; and in the year 1811 was returned as containing 26 houses, and 140 inhabitants.

WYCOMBE, HIGH, or *Chipping-Wycombe*, a large market and borough town in the hundred of Desborough, Buckinghamshire, England, is situated 34 miles S.E. from the county town, and 29 miles W. by N. from London, on the banks of a small river, which rises at West Wycombe, and, in its course through this parish, turns several corn and paper mills. A weekly market on Fridays has been held from time immemorial, and is a great mart for corn and

other articles: here is also an annual fair. This borough has sent members to parliament from the 28th year of Edward I.: the right of election is vested in the mayor, aldermen, bailiffs, and burghesses; and the number of voters is about 180. Edmund Waller, the poet, was one of the representatives in 1625; sir Edmund Verney, king Charles's standard-bearer, who fell at the battle of Edgehill, was elected to the parliaments of 1639 and 1640; and Thomas Scott, the regicide, was a member during the protectorate of Cromwell. The first incorporation of the town appears to have been in 1461; but the mayor and aldermen are mentioned in a record of the reign of Edward III.: the earliest charter now extant bears date 1586. The corporation consists of a mayor, twelve aldermen, a recorder, and other officers; formerly here was a high steward, but the office was annulled by a charter of Charles II.; yet since that time it has been held (by virtue of former charters) by the earl of Bridgewater, lord-chancellor Jefferies, and the marquis of Wharton. According to the population return of the year 1811, the town contained 494 houses and 2490 inhabitants: the parish is extensive, and includes several hamlets, which make an addition of 2266 to the population, and 449 to the number of houses. The manor of Wycombe having passed through a variety of families, was sold, together with the manors of Loakes and Windfors, or Chapel-fee, by Thomas Archdale, esq. in 1700 to Henry Petty, lord Shelburne, who bequeathed all his estates to his nephew, John Fitzmaurice, afterwards earl of Shelburne. His son, who in 1784 was created earl Wycombe and marquis of Lansdown, sold these manors by auction, which were purchased by the present proprietor, lord Carrington. The manor-house of Loakes, situated near the town, was considerably enlarged and improved by lord Shelburne, and the marquis of Lansdown bestowed much expence in laying out the gardens and pleasure-grounds. The house has been almost wholly rebuilt by the present noble owner, from the designs of James Wyatt: it is now called Wycombe-abbey. The parish-church of High Wycombe is mentioned by Warton as having been built in the reign of Henry II.: the present fabric is of much later date, and the tower was built in 1522. Between the aisle and the chancel is an ancient oak screen, which, by an inscription, appears to have been put up in 1460, at the expence of the Redhead family. In the chancel is a monument to Henry Petty, earl of Shelburne, who died in 1751. It was executed by Scheemakers, at the expence of 2000*l.*, which was bequeathed by his lordship for that purpose. In the south aisle is a very handsome monument by Carlini, for Sophia, countess of Shelburne, (first wife of the late marquis,) who died in 1791, with a female figure reclining on an urn. In the church are memorials of the families of Archdale, Lluelyn, Shrimpton, and Bradshaw. William Bradshaw, who died in 1614, was 103 years of age. In the church-yard is the tomb of Robert Williams, the late sexton, who died in 1793, at the age of 102. Two hospitals for lepers were founded in this town in the early part of the 13th century: one of them was granted by queen Elizabeth to the corporation; and the lands are now applied to the maintenance of a hospital or alms-house for poor people, and a grammar-school.

WYCOMBE, *West*, is a populous village and parish in the hundred of Desborough, situated about two miles N.W. by W. from High Wycombe, on the road to Oxford. It was anciently called Haverindon. The manor was from a remote period till the Reformation attached to the see of Winchester: the present proprietor is sir John Dashwood King, who has a seat here, named West Wycombe-house, which was built by sir Francis Dashwood, but was much enlarged,

enlarged, and furnished with a profusion of ornaments by his son lord Le Despencer. The parish-church stands on the summit of a steep hill, at a small distance from the village, within the site of an ancient circular intrenchment. It was rebuilt in 1763, (except the tower and chancel, which are parts of a more ancient structure,) by lord Le Despencer, who fitted it up in the Grecian style: the ceiling is painted with Mosaic ornaments. Near the east end of the church is an hexagonal building, erected by his lordship. One side of this building is inscribed to the memory of John, earl of Westmoreland, and another to George, baron of Melcombe Regis, whose legacy to lord Le Despencer, for the purpose of erecting a monument to his memory, was the cause of his lordship's building this singular mausoleum. Within it are several recesses for monuments, and niches for arms and busts. The population of this parish, in the return of the year 1811, is stated to be 1362; the number of houses 273.—Lyfons's *Magna Britannia*, vol. i. Buckinghamshire, 1806. *Beauties of England and Wales*, vol. i. Buckinghamshire, by J. Britton and E. W. Brayley, 1801.

WYDAW, a river of Denmark, which runs into the North sea, near Tondern, in the duchy of Sleswick.

WYDRAUGHT, a water-course, or water-passage, to carry off the filth and sullage of a house; properly a sink, or common-sewer.

WYE, in *Geography*, called by Leland, in his *Itinerary*, a "pratie market townlet," is now only a considerable village of the county of Kent, England, as its market has been long discontinued. In the *Domesday-book* it is written *Wi*, and by that appellation it was granted by the Conqueror to the abbey of Battle, in Suffex, which he had founded in remembrance of his victory over Harold, it having been previously a part of the demesne lands of the Saxon kings. "The *Chronicles of Battle abbey* affirm," says Lambard, "that there were sometime two-and-twenty hundredths subject to the jurisdiction of this manor." The extensive grant of the royal manor of Wye, with all its appendages, liberties, and royal customs, was confirmed to the abbey of Battle by different sovereigns, and it continued parcel of its possessions till the period of the dissolution. Queen Elizabeth, in her first year, granted it, together with various estates in the vicinity, to her kinsman, Henry Cary, lord Hunsdon, to hold *in capite* by knight's service. The church of this parish was made collegiate by archbishop Kemp, who was a native of the place, and is supposed to have rebuilt this edifice at the same time that he founded the adjoining college, in the year 1447. It consists of a nave, aisles, and chancel, with a large embattled tower at the south-east angle; the nave is separated from the aisles by four pointed arches on each side, rising from clustered columns; the chancel was rebuilt at the commencement of the last century, and has a semicircular east end.

The ancient college, now the grammar-school, founded by archbishop Kemp, stands on the east side of the church-yard. He endowed it for a provost and six fellows, "two of whom had an additional stipend for the duty of the church, and care of a grammar-school," in which all scholars, both rich and poor, were to be instructed gratis. Another school was instituted here about the year 1708, under a bequest of lady Joanna Thornhill, who, among other charities to the poor of Wye, directed that the residue of her estates should be applied to the instruction of their children. Sir George Wheeler added to this foundation, and gave the college as the residence for the master of the grammar-school, and for the master and mistress of lady Thornhill's school. The college buildings form a quad-

rangle, and the old hall is a large vaulted room, now used for the school. The population of this parish in the year 1811 consisted of 1322 persons, who occupied 224 houses. In this parish is Ollantigh, where archbishop Kemp was born in 1380, and where towards the end of his life he built a chapel, or oratory. Here also it is conjectured was born Thomas Kemp, bishop of London, and nephew of the archbishop. John Sawbridge, a patriotic alderman of London, was likewise a native of this place, where he was born March 17, 1732, and where he died in 1795. His sister, Mrs. Macaulay Graham, an English historian, derived her birth from this place on the 23d of March 1731. (See GRAHAM, MACAULAY.) About one mile N.E. from Ollantigh, a Roman burying-place was discovered in the year 1703, and several skeletons, urns, and other vestiges of interments, have been discovered, and are now preserved at Heppington, in this county.—Hasted's *History, &c. of Kent*, 12 vols. 8vo. *Beauties of England, &c. Kent*, by E. W. Brayley, 8vo. 1806.

WYE, a river of South Wales, is rendered particularly noted, in consequence of the high praises bestowed on it by topographers, tourists, and poets. The shores of this famed stream are distinguished by bold, rocky, and woody scenery, and adorned by several towns, seats, castles, and abbeys. The poet Gray says, "its banks are a succession of nameless beauties." Taking its source on the south side of the mountain called Plinlimmon, in Montgomeryshire, within a quarter of a mile from the spring-head of the river Severn, the river takes a course in general to the S.E. between the counties of Brecknock on the W. and Radnor on the E. Entering Herefordshire, it winds by and partly through the capital of that county; and then turning southward, it forms the boundary between Gloucestershire on the E. and Monmouthshire on the W., until it unites its stream with that of the Severn, a few miles below Chepstow. At its source, the scenery is wild, romantic, and bare; but after descending to Bualt, the scenes are extremely beautiful. In the valley of Glasbury, the stream is so considerable as to have required in 1783 a stone bridge of seven arches, which twelve years afterwards was swept away by the floods. At Hay, where it enters Herefordshire and receives the waters of the Dulas, the Wye is so much increased in the winter season as to be navigable for barges. From thence to Hereford it winds through a continuation of rich and beautiful scenes, and passes by many pleasant villages and country-seats. Bradwardine, a village, where in ancient times stood a castle, on the right or south bank, gave name to Thomas Bradwardine, archbishop of Canterbury, who was styled from the depth of his learning "the profound doctor." About three miles lower down is Moccas-court, the modern residence of sir George Cornwall, bart. About six miles below Hereford the Wye receives the Lug, one of the three principal rivers of the county, flowing in general south-east from the borders of Radnorshire. "Near the conflux of the Lux and Wye," says Camden, "to the east, a hill called Marclay-hill did, in the year 1575, rouse itself as it were out of sleep, and for three days together, shoving its prodigious body forward, with a horrible roaring noise, raised itself, to the great astonishment of all beholders, to a higher place." Two miles below the influx of the Lug, but on the west side of the Wye, is Holme-Lacy, the ancient seat of the Scudamores, the heirs of whom married the late duke of Norfolk. The mansion occupies the site of an abbey, which was founded in the time of Henry III. Five or six miles lower down, and on the same side of the Wye, is Harewood, a remnant of the forest of that name, selected by

by Maſon as the ſcene of his drama of *Elfrida*; for there Ethelwold, the confidante of king Edgar, had his caſtle, in which the fair *Elfrida* was concealed. Five miles farther down, on the eaſt bank of the river, is Roſs, conſecrated in the poetry of Pope by his fascinating deſcription of what could be and actually was accompliſhed by the “Man of Roſs,” with “five hundred pounds a year.” The memory of this worthy man, John Kyrle, is preſerved by a monument in the church of Roſs. On the weſt ſide of the river are the remains of Wilton caſtle, a Norman ſtructure, once the reſidence of the Greys. Following the courſe of the Wye on the weſt, on the ſummit of a bold promontory clothed with wood appear the lofty towers of Goodrich caſtle, of great antiquity; for in 1204 it was granted by king John to Marſhall, earl of Pembroke. The views from the caſtle are extenſive and highly intereſting. At Coldwell rocks the ſcenery of the Wye is peculiarly grand, the prominences are overhung with oaks and ſhrubs, and ſeparated by deep ſhadowy dells. From Symond’s-gate or Yat, the ſummit of a lofty hill, the ſpectator diſcovers a ſingularly grand view of the windings of the river, and its romantic banks. Soon afterwards, entering a ſhort way into Monmouthſhire, the Wye bathes the walls of the capital, near which is Troy-houſe, the ancient feat of the duke of Beaufort, and aſſuming a ſouthern direction, runs along the limit between that county and Glouceſterſhire. The courſe of the river, in the latter part of the range, is leſs irregular than that through Herefordſhire, but it is not leſs intereſting. About a mile diſtant from its eaſt bank, on an eminence, ſtands St. Briavel’s caſtle, once of great extent and great ſtrength, erected by Miles, earl of Hereford, in the reign of Henry I. Lower down the ſtream and on the weſt bank is the curious village of Llandogo, diſperſed among trees on the ſide of a hill. Proceeding down the river by an eaſy bending courſe, in the midſt of very pictureſque ſcenery, appear the dilapidated and highly pictureſque remains of Tintern abbey, at the opening of a valley on the weſt bank. This venerable ruin is apparently incloſed by ſteep hills and hanging woods, which are ſeparated by the broad ſtream in the bottom. Paſſing much ſcenery equally beautiful, the eaſt bank of the river preſents a ſcreen of rocks, called Thorn and Black Cliffs, to which the tide reaches, and afterwards marſhy lands appear on both ſides. Next appear the rocks belonging to the celebrated grounds of Piersfield. Theſe reſemble the projecting baſtions of a caſtle, and powerfully reverberate ſounds that ſtrike againſt them. A little lower down is the Lover’s Leap, a precipitous rock; and the next ſweep of the river brings before the eye the noble remains of the caſtle of Chepſtow, perched on the ſummit of a lofty perpendicular cliff, impending over the weſt ſide of the river. The ſituation of the caſtle and the town of Chepſtow is peculiarly pictureſque. The beauties of the ſcene are, in the opinion of Mr. Wyndham, “ſo excellent, that the moſt exact critic in landſcape would ſcarcely wiſh to alter a poſition in the aſſemblage of woods, cliffs, ruins, and water.” Chepſtow caſtle is undoubtedly ancient, and Roman-Britiſh bricks are diſcovered in the walls; but its foundation can be traced only to Fitzoſborne, earl of Hereford, who erected it for the defence of the poſſeſſions he received from William of Normandy. Notwithſtanding the height and rapidity of the tides at Chepſtow, a bridge has long been eſtabliſhed there acroſs the Wye. It was formerly conſtructed wholly of timber, but is now made of caſt-iron. Although the tide be ſenſibly perceived only about Tintern abbey, five miles above Chepſtow, yet the water riſes in the river at this town to a very extraordinary

height. Formerly not leſs than ſeventy feet, as it is aſſerted; but fifty-fix feet is the greateſt riſe obſerved during the laſt hundred years. The tide ſetting up the Briſtol channel from the Atlantic is, by the gradual contraction of its courſe, forced to ſwell up in a very uncommon manner; and its progrels is ſtill farther impeded by the advance of the land on the north of the entrance of the Wye, up which river, as well as more directly up the Severn, it ruſhes with peculiar force. In deſcending the Wye from Chepſtow, the high impending rocks have a very ſtriking effect. At the conflux with the Severn, three miles below the town, the eſtuary of the latter river appears, bounded by the diſtant hills of Glouceſterſhire and Somerſetſhire. The general character of the river Wye is thus repreſented by Mr. Coxe: “It is diſtinguiſhed by its ſerpentine courſe, the uniform breadth of its channel, and the ſcenery of its banks. In the navigable part from Hereford downwards, the banks for the moſt part riſe abruptly from the edge of the water, and are clothed with foreſts and broken cliffs. In ſome places they approach ſo near that the river occupies the whole intermediate ſpace, and nothing is ſeen but wood, rock, and water: in others they alternately recede, and the eye catches an occaſional glimpe of hamlets, ruins, and detached buildings, partly ſeated on the margin of the ſtream, and partly ſcattered on the riſing grounds. The general character of the ſcenery, however, is wildneſs and ſolitude: and if we except the populous diſtrict of Monmouth, no river perhaps flows for ſo long a courſe through a well-cultivated country, the banks of which exhibit ſo few habitations.” Large hoys fitted to navigate the Severn can, with the tide, aſcend the Wye to Brookſwear, a populous village midway between Monmouth and Chepſtow, where they receive from and transfer into ſmall craft the various commodities with which they are loaded. The Wye as well as the Severn furniſhes a conſiderable quantity of ſalmon.—*Beauties of England and Wales, North Wales*, by the Rev. J. Evans, 8vo. 1810. Ditto, *Monmouthſhire*, by J. Britton, 1808. *Historical Tour in Monmouthſhire*, by the Rev. William Coxe, 2 vols. 4to. 1801. *Observations on the River Wye*, by the Rev. William Gilpin, 8vo. 1789.

WYE, a river of England, which runs into the Derwent, near Bakewell.—Alſo, a river of Maryland, which runs into the Cheſapeak, N. lat. 38° 54'. W. long. 76° 20'.

WYENOKE, a town of Virginia.

WYERSDALE, NETHER, a townſhip in the hundred of Amounderneſs, county palatine of Lancaſter, England, is ſituated four miles N.N.E. from Garſlang, and was ſtated in the return of the year 1811 to contain a population of 713 perſons, occupying 145 houſes.

WYERSDALE, Over, a townſhip in the hundred of Lonſdale South of the Sands, Lancaſhire, England, is ſituated ſix miles N.N.E. from Garſlang, and in the year 1811 contained 154 houſes and 802 inhabitants. A colony of Ciſtercian monks were for ſome time fixed here, but about A.D. 1188 they removed into Ireland, and founded the abbey of Wythney.

WYERSDALE *Foreſt*. See LANCAſHIRE, *Foreſts in*.

WYFFLERS, in *Military Language*, ſubordinate officers in the Engliſh infantry, whole buſineſs, in the time of queen Elizabeth, appears to have been to drill the men, to inſtruct them how to carry their arms, and to arrange them according to their ranks in proper order.

WYFORDBY, or WYVERBY, in *Geography*, a ſmall pariſh in the hundred of Framland, county of Leiceſter, England, is ſituated three miles E. from Melton Mowbray; and in the population report of 1811 was returned as containing

taining 20 houses, and 97 inhabitants. It includes the hamlet of Brentingby.

WYGBYGERA, a town of Sweden, in Angermannland; 30 miles N. of Hernofand.

WYGELN, a high mountain of Norway.

WYHAM, a parish in the wapentake of Ludborough, in Lindsey division of the county of Lincoln, England, is situated 7 miles N.N.W. from Louth; and was stated in the year 1811 to have a population of 87, occupying 10 houses.

WYHOMICA, or WYHONIEC, a town of Lithuania; 20 miles N.N.E. of Pinsk.

WYK, a town of Sweden, in the province of Smaland; 65 miles N.N.W. of Calmar.

WYKA, a town of Sweden, in Dalecarlia; 14 miles S.E. of Fahlun.

WYKE, anciently denoted a farm, hamlet, or little village.

WYKE, in *Geography*, a tything in the parish of Worplesdon, hundred of Woking, county of Surrey, England, is situated 6 miles W. by N. from Guildford, and was returned in the year 1811 as containing 30 houses, and 125 inhabitants.

WYKE *Regis*, a parish in the hundred of the same name, in Dorchester division of the county of Dorset, England, is 2 miles W.S.W. from Weymouth. The population in the year 1811 was returned as 570, the number of houses as 134. The church, which is the mother-church to Melcombe Regis, is a spacious building, with a lofty tower, serving as a land-mark. From this village there is a ferry to Portland isle.

WYKE-Hamon, a parish in the hundred of Cleley, Northamptonshire, England. The church is in ruins. The population is included with that of the adjoining parish of Wykens, or Wyke Dyve.

WYKEHAM, in *Biography*. See WILLIAM of Wykeham.

WYKEHAM, or *Wycombe*, in *Geography*, a township in the hundred of East Goscote, county of Leicester, England; 5 miles N.E. by N. from Melton Mowbray. The population, including the adjoining township of Caldwell, was in 1811 stated to be 95, occupying 25 houses.

WYKEHAM, a township in the east division of the wapentake of Pickering Lythe, North Riding of the county of York, England, is 6 miles S.W. by W. from Scarborough; and in the year 1811 contained 87 houses, and 511 inhabitants. About the year 1153, Pain Fitz Osbert built and endowed a priory for Cistercian nuns at this place. At the dissolution there were nine religious persons in the house, with an estate of 25*l.* 17*s.* 6*d.* per annum. Henry VIII. granted the house to Francis Poole.

WYKEHAM, *East*, is a parish in the Wold division of Louth-Eske hundred, in Lindsey part of Lincolnshire, England, situated 7 miles N.W. by W. from Louth. The church is in ruins. The population was stated, in the return of the year 1811, to be 23, the number of houses 4.

WYKEHAM, *West*, is a parish in the east division of the wapentake of Wraggoc, in Lindsey division of Lincolnshire, England, adjoining to the foregoing. The church is also in ruins.

WYKEN, a parish in the county of the city of Coventry, Warwickshire, England, is 3 miles N.E. by E. from the city; and, according to the population return of the year 1811, contained 13 houses, and 72 inhabitants.

WYKENS, or WYKE-DYVE, a parish in the hundred of Cleley, county of Northampton, England, situated 7

miles S.E. by S. from Towcester, and 3 miles W.S.W. from Stony-Stratford; Bucks. This parish is united with that of Wyke-Hamon, and in 1811 the joint population was returned as 385, the number of houses as 57.

WYL. See WEYL.

WYLAM, a township in the parish of Ovingham, Tyne-dale-ward, county of Northumberland. In the year 1811 it contained 159 houses, and 795 inhabitants; 9 miles W. from Newcastle.

WYLDE, JOHN, in *Biography*, the author, or rather the compiler of a tract on music in the MS. of Waltham Holy Cross, now in the possession of the marquis of Lansdown, entitled "Musica Guidonis Monachi." It is the first in the volume, but not written by Guido, as the title seems to imply, but an explanation of his principles; it is divided into two books, and appears to have been compiled by the precentor of Waltham abbey, John Wylde, pr. "Quia juxta Sapientissimum Salomonem dura est." The author does not confine himself to the doctrines of Guido, but cites later writers. The basis of the tract, however, is the *Misero-logus*, and his other writings, in which he treats of the monochord, the scale, the harmonic hand, the explanation of which he calls *manual music*, ecclesiastical tones, solmification, clefs, with a battle between B flat and B natural, are the subjects of the first book, consisting of twenty-two chapters.

The second book, or distinction, contains thirty-one chapters. In the first he speaks of a Guido Minor, surnamed *Augensis*, as a writer on the ecclesiastical chant. He had mentioned this author in the seventh chapter of the first book; but who he was, or when he lived, we are unable to discover. It seems, however, as if some such musical writer had existed, and that his name, by the ignorance or inattention of the scribes of ancient MSS., had been confounded with that of Guido d'Arezzo.

In several of the succeeding chapters he treats of intervals and their species, offering nothing new or singular, except where he draws a parallel between the tone and semitone, and Leah and Rachel, Jacob's wives, which, it is presumed, will excite no great curiosity in our readers.

Attention is engaged, however, in the tenth chapter, by a "Cantilena," as the author calls it, of the Great Guido. It is a kind of *solfe-ggio*, or exercise for the voice, through all the intervals, which is only rendered valuable, perhaps, by the supposition of its having been produced by the celebrated author of the musical alphabet. See SERRA.

WYLIA, in *Botany*, another new umbelliferous genus of professor Hoffmann's, (see WENDIA,) dedicated by its author to Dr. J. Wylie, privy counsellor to the emperor of Russia, inspector of medicine and surgery in the Russian army, &c. &c., author of a *Pharmacopœia Castrensis Ruthena*, in which his highly commendable aim has been to indicate the medical properties, and to fix the names of the native plants of Russia.—Hoffm. Gen. Plant. Umbellif. v. 1. 3. t. 2.—Class and order, *Pentandria Digynia*. Nat. Ord. *Umbellatae*, Linn. *Umbellifera*, Juss.

Gen. Ch. *General Involucrum* of one ovato-lanceolate, membranous, half-clasping leaf, fringed with hairs; *partial* of five ovate, nearly entire, concave, two or three-ribbed leaves, bordered with a pellucid fringed membrane. *Petioles* of five minute teeth, permanent. *Cor.* universal irregular; flowers of the disk perfect, fertile, as well as the female ones which form the radius; some male flowers are either interperfed in the disk, or disposed in separate umbels: *partial* of five petals; unequal in the flowers of the radius, the outermost very large, either obovate and flattened,

tened, or inverfely heart-shaped, with a long claw; equal in thofe of the difk. *Stam.* Filaments five, thread-shaped, at firft inflexed, and concealed in the hollows of the petals, afterwards prominent; anthers roundifh. *Pift.* Germen ovate-oblong, more or lefs tapering; ftyles erect, thread-shaped, nearly equal, ftanding on a cup-shaped bafe; ftigmas fimple. *Peric.* Fruit linear-oblong, beaked, fomewhat compressed, crowned with the erect, permanent ftyles, and their cup-like, flightly notched bafis. *Seeds* two, linear-oblong, bifpid, ftriated, the ribs elevated, continued into the beak with intermediate furrows; valves of the beak parallel to the fruit.

Eff. Ch. General and partial involuclral leaves ovate. Flowers polygamous, radiant. Calyx five-toothed. *Fruit* oblong, fomewhat compressed, beaked; valves of the beak parallel to the fruit.

Obf. The chief differences which have led professor Hoffmann to feparate this genus from SCANDIX, (fee that article,) appear to be the nearly entire leaves of the partial involuclrum, which are lacinated in *Scandix*; the radiant corolla, and, as he fays, the valves of the beak being parallel, not contrary to the fruit; that is, as we prefume, compressed in a contrary direction in one genus to what they are in the other. For this we rely on the learned and judicious author not having materials fufficient to verify his obfervation. We muft remark, that the involuclral leaves in *Wylia*, though not lacinated, have a notch or two at the end, and precifely accord in texture with thofe of *Scandix*. Many of the umbels in this genus are fimple, or occasionally two or three together, refembling a compound umbel.

1. *W. australis.* Southern *Wylia*. Hoffm. n. 1. t. 2. f. 1. (*Scandix australis*; Linn. Sp. Pl. 369. Sm. Fl. Græc. Sibth. t. 285, unpubl. See SCANDIX n. 6.)—Umbels fimple, or in pairs, of few flowers. Radiant petals obovate, nearly entire. Beak of the fruit almoft ftraight.—Native of fields in Italy and the Levant, as well as in Tauria, about Sudak, flowering in May. *Root* annual. *Herb* fender. *Stem* round, fometimes quite fmooth, fometimes more or lefs hairy. *Leaves* triply pinnate, with linear acute fegments, and hairy, or rather fringed *footstalks*. *Umbels* final and dense, on long ftalks; the lower ones oppofite to the leaves, folitary and fimple; upper in pairs, rarely three together, and even in that cafe not conftituting a real compound umbel, as an examination of fpecimens will readily fhew. *Flowers* white, moderately radiant. *Largelt petals* fometimes flightly emarginate. *Fruits* from fix to ten perfected in each umbel, their beaks nearly or quite ftraight, quadrangular, rough with fhort erect briftles.

2. *W. radians.* Radiating *Wylia*. Hoffm. n. 2. t. 2. f. 2. (*Scandix australis* β; Marfch. Taur.-Caucas. v. 1. 424. S. falcata; Londe Journ. de la Soc. des Natural. de Mofcou, for 1806, 57. t. 5.)—Umbels aggregate, from two to five, many-flowered. Radiant petals elongated, wavy. Beak of the fruit incurved.—Frequent in Tauria, flowering in May. This is confidered by the authors who have defcribed it as about equally related to the foregoing and to the *grandiflora*. We have no other guide than a beautiful engraving, copied by Hoffmann from the figure above cited, with the addition of the magnified and diflected fructification. By this it appears that the partial umbels are rather more numerous affembled, making more apparently compound umbels. The *flowers* are more confpicuoufly radiant. *Fruits* more numerous in each umbel, from twelve to twenty, with ftrongly incurved rough beaks. We confeff ourfelves unable to determine thefe two fpecies clearly by

the fpecific differences of professor Hoffmann, which we fubjoin for the fatisfaction of our readers.

W. australis, caule petiolifque hirtutis, corollis petalifque radiantibus obovatis integris.

W. radians, caule petiolifque pilofis, umbellis glabris, corollis petalis fructibusque radiantibus.

The hairinefs is evidently variable, and the other characters, perhaps from fome typographical error, do not contraft with each other.

3. *W. grandiflora.* Large-flowered *Wylia*. Hoffm. n. 3. t. 2. f. 3. (*Scandix grandiflora*; Linn. Sp. Pl. 369; fee SCANDIX n. 10. Marfch. Taur.-Caucas. v. 1. 230.)—General umbels of from three to five very hairy rays. Radiant petals flightly emarginate.—Native of fields in Tartary and Georgia, flowering in May and June. Having difcovered a fpecimen of this in our collection fince the article SCANDIX was written, we are enabled to compare it with the defcriptions of authors, and to felect the following particulars:—The *root* is annual, tapering. *Stem* about a foot high, round, purplifh, flightly branched, quite fmooth in our fpecimen; Hoffmann fays clothed with long hairs. *Leaves* much like the laft; their *footstalks* fomewhat hairy. *Umbels* terminal; the *general* ones fometimes on fhort ftalks, each compofed of from three to five long, fender, coarfely and abundantly hairy rays, with a leafy, fimple or divided, linear leaf, in the place of a general involuclrum. *Partial umbels* of numerous fhort fmooth rays; their *involuclrum* of fveral, moftly double-pointed, ovate, white-edged, fringed leaves. *Flowers* remarkably radiant; their *largelt petals* obovate, not always emarginate, each furnifhed with a long claw. Beak of the *fruit* rather fealy, as Hoffmann delineates it, than hairy. His figures, in this and the other fpecies, except *radians*, exhibit the parts of fructification only.

4. *W. iberica.* Georgian *Wylia*. Hoffm. n. 4. t. 2. f. 4. (*Scandix iberica*; Marfch. Taur.-Caucas. v. 1. 425. S. falcata; ibid. 230, excluding the fynonym.)—General umbels of four or five very fmooth rays. Radiant petals emarginate, with an inflexed point. *Stem* fomewhat hairy at one fide.—Native of Georgia. Annual. Very nearly related to the laft in habit and fize. The *ftem* is, as in that, fometimes quite fmooth. The rays of both general and partial umbels are faid to be always very fmooth. Radiant petals of a fmall proportion, and, as it feems to us, effentially diftinguifhed by their fhort inflexed points. The beak of the *fruit* is defcribed as marked with two hairy lines, and not hairy in every direction. We have feen no fpecimen.

WYLSTER, in *Geography*. See WILSTER.

WYMERING, a parifh in the hundred of Portfdown, Hampfhire, England, returned in the year 1811 as containing 121 houfes, and 740 inhabitants; 4 miles W. from Havant.

WYMINGTON, or WIMMINGTON, a parifh in the hundred of Willey, county of Bedford, England, is fituated 12 miles N.W. by N. from the county town, and about 3 miles from Higham Ferrers, Northamptonfhire. Wymington church, a fine ftructure, was built by John Curteys, then lord of the manor, and mayor of the ftaple at Calais, who died in 1391, as appears from an infcription on his tomb. The braffes of himfelf and his wife are on a flab of black marble under canopies, and are well preferved. The population of the parifh, in the return of 1811, was ftated to be 235, the number of houfes 40.

WYMOA BAY, a bay on the S. coaft of Atooi, one of the Sandwich iflands. N. lat. 21° 57'. E. long. 200° 20'.

WYMONDHAM, or WINDHAM, a market-town in the hundred

hundred of Forehoe, and county of Norfolk, England, is situated 9 miles W.S.W. from Norwich, on the great road to London, from which it is distant 100 miles N.E. by E. This place has been supposed to be of Roman origin; and some writers have considered it as the Sitomagus of the Itinerary, though there are not the smallest traces to support that opinion. The name is purely Saxon; and the consequence of the town arose from the erection of a monastery here in the time of Henry I. A.D. 1130, by William de Albini, who amply endowed it with lands, which were confirmed with additions and privileges annexed by the reigning monarch. From the register of St. Alban's, this religious house appears to have been originally founded as a cell for black monks of the Augustine order; and its annual revenues at the dissolution amounted, according to Dugdale, to 211*l.* 16*s.* 6*d.* By the inquisition made at that period, the monastery was found in a regular state; and the abbot and monks in general were declared to have led blameless lives. The abbey-church was a large, handsome, cruciform building, erected soon after the year 1130. It consisted of a choir, nave, transept, north and south aisles, with a tower standing in the centre, still called the abbey-teeple, and another at the west end. When the monastery was destroyed, the south aisle, over which were lodgings for supernumerary monks, was demolished: but the king granted the inhabitants leave to build another. Anxious to preserve their noble church, they also obtained the following parts, which had been condemned by the act for removing superstitious buildings:—The abbey, teeple, vestry, monks' lodgings over the south aisle, St. Margaret's chapel, the chapel of the Blessed Virgin, the chapel of St. Thomas à Becket, and the choir. These were granted on condition that the inhabitants paid the king for the lead at the rate of 4*l.* per fodder, of twenty-four square feet.

The present church consists of a nave with aisles, a large western tower, and another at the intersection of the nave with the transepts. The ancient parts of the building display semicircular arches with short columns, large piers, &c. which appear to be parts of the original structure. At the east end, and on the south side of the porch, are some fragments of walls. The north aisle, porch, and towers, are of a much later style than the nave and south aisle. The church is curious, and highly interesting to the architectural antiquary and draughtsman. In it is a large font, ornamented with bold sculpture, and raised on steps. The remains of the founder were interred in the choir in 1156. The families of Albini, earls of Arundel, of Knevet, and of Clifton, are deposited in this church. Several guilds were founded here, the revenues of which have been appropriated to other purposes. Wymondham parish is extensive, and comprehends several hamlets, which are called the outfoken division, whilst the town is divided into several parts called the infoken division. Many of the inhabitants are employed in various branches of weaving. The distinguished family of Wyndham, or Windham, derives its name from this place.

North of the town is Kimberly-hall, the seat of lord Wodehouse. The house is seated in an extensive and beautiful park, which contains a fine piece of water, and some noble masses of forest-trees. In the house is a portrait of Vanduyck, by himself, when a young man.—Blomefield's History, &c. of Norfolk, 11 vols. 8vo. Beauties of England, Norfolk; by J. Britton, 8vo. 1809.

WYMONDHAM, a parish in the hundred of Framland, county of Leicester, England, situated 6 miles E. from Melton Mowbray, and 104 miles N.N.W. from London.

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It is very ancient, and was formerly furrounded with walls: the inhabitants still possess an exemption originally granted to the duchy of Lancaster. In the return of the year 1811, the population was stated to be 437, occupying 81 houses.

WYMONDLEY, or WYMONDESLEY, *Great*, a parish in the hundred of Brinkwater, county of Hertford, England, situated within three miles E.S.E. from Hitchin. The manor was given by William the Conqueror to a noble Norman, named Fitz-beck, by the service of grand sergentry; that the lords of the said manor should present to the kings of England the first cup of drink at dinner on the day of their coronation: the cup becoming the property of the said lords. This service has continued with the manor: lieutenant-colonel Cracherood performed the office of cup-bearer at the coronation of George III. The population of the parish was, in the return of 1811, stated to be 212, and the number of houses 46.—*Beauties of England and Wales*, vol. vii. Hertfordshire, by E. W. Brayley.

WYMONDLEY, or *Wymondesley, Little*, is also a parish in the same hundred, adjoining to Great Wymondley, and containing, in the year 1811, 34 houses, and 188 inhabitants. A priory of Austin canons was founded here by Richard de Augustine, in the time of Henry III.: the site was granted to James Needham, gent., clerk of the king's works, in whose descendants it continued till the death of George Needham, esq. in 1726. It was then sold to Samuel Vanderplank, esq., and was lately the property of Christopher Clitherowlsy, who married Mr. Vanderplank's granddaughter.

Wymondley-house, in this vicinity, formerly the residence of a private gentleman, is now an academy for the education of Protestant Dissenting ministers. This institution originated at Northampton in 1729, by the endowment of William Coward, esq. a West India merchant. The celebrated Dr. Doddridge was the first tutor, which office he held twenty-two years. In 1752 the academy was removed to Daventry, and thence back to Northampton; and finally in 1799 to this place, having been previously united with an academy in London, under the successive tuition of Mr. Eames, F.R.S., Dr. Jennings, Dr. Savage, Dr. Kippis, and Dr. Rees, supported by the same fund, and unfortunately for the interests of literature and science discontinued. The library contains a valuable assemblage of upwards of 10,000 volumes of the best authors in divinity, criticism, classics, mathematics, topographical antiquities, &c. with a cabinet of medals, a collection of natural history, and other curiosities. This valuable library consists principally of a rich collection of books, bequeathed by the late Rev. Mr. Miles, F.R.S., and appropriated to the London Academy, and augmented by numerous purchases.—*Beauties of England and Wales*, vol. vii. by E. W. Brayley. And Private Information.

WYNANTS, JOHN, in *Biography*, an able and eminent landscape-painter, born at Haerlem in 1600. Whether he were his own instructor or not does not appear, or how he qualified himself to attain that station among the artists of his country which he so justly holds. His pictures are taken from the simple scenes of nature which surrounded his birth-place, and which he has represented with great vivacity and reality, though they sometimes are overcharged in their contrasts of colouring. A sandy bank, with broken patches of grass and plants, with stunted trees beside it, and a winding road passing over the bank, presents from his pencil an agreeable and interesting effect. Sometimes we find the entrance of a wood, with a cottage or lovel

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beside

beside it, treated by him with great attention to the varied effect of colour in nature, and a dexterous management of chiaro-oscuro; and always with the most free and skilful touch, though generally upon a small scale. As he painted with facility, his works are not rare, though they bear a good price when in perfect preservation. Wynants established an academy, which produced many excellent painters. Among others of great celebrity, were Adriaan Vanderveelde and Philip Wouwermans, both of whom occasionally embellished their master's pictures with figures. He died in 1670, aged 70. He left numerous beautiful etchings of landscapes.

WYNNE, *Mrs.* CASSANDRA FREDERICA, the finest harpsichord player of her time. She was the daughter of signora Pompeati, the second female singer in Gluck's opera of "La Caduta de Giganti," performed in 1746, on the suppression of the rebellion; but though she nominally performed the part of second woman, she acted and sung in so masculine and violent a manner, that no female symptoms were discoverable. But this lady was better known afterwards by the name of Madame Cornellys, whose concerts, *ridottas*, assemblies, and masquerades, in Soho-square, were the gaiest and most fashionable amusements in London during many years.

The little Frederica, daughter of the Pompeati, was an élève of Paradie's, (some say his daughter,) and the first early player, the neatest, and the best which had ever appeared in our country during infancy, performing at six years old, with the utmost precision and firmness, propped up by cushions, the whole book of her master's twelve excellent lessons, probably composed expressly as progressive exercises for her use, with many lessons by Scarlatti and Alberti.

In 1769, when grown up, she went into Italy, where she was the wonder and subject of elege in that mother and seat of arts. We have often heard her perform at different periods of her life, and continued to think her improved to the last.

WYNNE, ———, esq., a Yorkshire gentleman, one of the best dilettanti performers on the violin that we have heard. He was a man of fortune, and of an ancient family. To gratify his passion for music, he went into Italy early in life, where he married, and remained in different great cities till he had almost totally forgotten his mother-tongue. He likewise travelled through Germany, and having two daughters, he had always a music-master on his establishment, not only to instruct them, but to accompany himself. When he was last in England, he had Pfeifer with him for these purposes, a worthy German, and an excellent musician and performer on several instruments, who died in London of a consumption.

Besides being a good performer on the violin, Mr. Wynne had studied composition sufficiently to compose trios, which were far above the common run of trios at that time in point of taste and invention, and well put together.

WYNSBACH, in *Geography*, a town of Austria; 4 miles E. of Schwannastatt.

WYNSTER. See WINSTER.

WYOMING, a settlement and fort on the river Susquehanna. In the year 1778, this fort was attacked by a party of British and Indians. The garrison were soon overpowered, and fell a prey to Indian barbarity; after a bloody military execution of a great part, the rest were shut up in the barracks, to which they set fire, and consumed the whole; 2 miles above Wilkesbarre.

WYONOKE CREEK, a river of North Carolina, which runs into the sea, N. lat. 36° 30'.

WYRARDSBURY, or WRAYSEBURY, a parish in the hundred of Stoke, and county of Buckingham, England, is situated near the banks of the Thames, 3 miles S.W. from Colnebrooke, and 3 miles N.W. from Staines, Middlesex. The manor belonged to the priory of Ankerwyke, in the same parish, which was founded in the reign of Henry II. for Benedictine nuns by Gilbert de Montfichet and his son Richard. In 1538 the priory was given to Bisham abbey, and after the dissolution it was granted to lord Windsor. Having afterwards reverted to the crown in exchange, it was given by Edward VI. in 1540 to sir Thomas Smith, the celebrated statesman, who resided at Ankerwyke. It was afterwards for many years the seat of the Salter family, of whom it was purchased by the Lees; and by marriage with an heiress came into the possession of sir Philip Harcourt, ancestor of the present proprietor, John Simon Harcourt, esq. There are no remains of the conventual buildings. Soon after the dissolution a mansion was built on the site by lord Windsor, or sir Thomas Smith: the hall of this mansion still remains. Near the house is a remarkably large yew-tree, which at six feet from the ground measures thirty feet five inches in girth. In the parish-church are monuments of the Harcourt family; and also of Thomas Wright, esq. and Thomas Gill, esq. aldermen of London, who died within a fortnight of each other in the year 1798. The population return of the year 1811 states this parish to contain 120 houses, and 560 inhabitants. The parish was inclosed by an act of parliament passed in the year 1799: a parcel of the waste was allotted for the purpose of holding a fair on the Friday in Whitsun week, pursuant to ancient custom.—Lysons's *Magna Britannia*, vol. i. Buckinghamshire.

WYRE, a river of Lancashire, which runs into the Irish sea, 9 miles W. of Garstang. N. lat. 53° 53'. W. long. 2° 56'.—Also, a river of France, which joins the Semoy, 3 miles E. of Chiny.

WYRIL POINT, a cape of England, on the coast of Durham. N. lat. 55° 3'.

WYSAUKING CREEK, a river of Pennsylvania, which runs into the E. branch of the Susquehanna, N. lat. 41° 46'. W. long. 76° 27'.

WYSOCKS, a township of Pennsylvania, in the county of Luzerne, containing 619 inhabitants.

WYSOKIE, a town of Lithuania, in the palatinate of Brzesk; 16 miles N. of Brzesk.

WYSTIEZE, a town of Lithuania, in the palatinate of Brzesk; 8 miles N.E. of Brzesk.

WYSZOCK, a town of Lithuania, in the palatinate of Brzesk; 44 miles S.E. of Pinsk.

WYTA, or WITA *Plena*, signified a forfeiture of a hundred and twenty shillings. "Si pundbreche fiat in curia regis, plena wita sit; alibi, quinque marcae."

To swear according to the wyte, *secundum wita[m] jurare*, was to purge one's self by the oaths of so many witnesses, as the nature of the crime, and the punishment, or wyte, did require.

Hence, also, *bloodwite*, *legerwite*, *ferdwite*, *childwite*, *wardwite*, &c. See *Ferd-Wite*, *Child-Wite*, &c.

WYTE, WYTA, or WITE, WITA, in our *Ancient Customs*, a pecuniary penalty, or mulct.

"Jurat secundum wita[m], quod nec fuerat furti conscius, nec coadjutor in eo." Leg. Inæ.

The Saxons had two kinds of punishments, *were* and *wyte*; the first for the more grievous offences.

W Y T

The *wyt* was for the less heinous ones. It was not fixed to any certain sum; but left at liberty, to be varied according to the case.

Hence also *wyte*, or *wittree*, one of the terms of privilege granted our sportsmen; signifying a freedom or immunity from fines or amerciaments: or, as it is vulgarly conceived, from being liable to be begged for fools, for lack of wit.

WYTHE, in *Law*, the same as waif.

W Z E

WYTHE, in *Geography*, a county of Virginia, between the river Kanhawa and North Carolina, with 8356 inhabitants, including 1157 slaves.

WYTHERS. See WITHERS.

WYTOOTACKEE, in *Geography*, an island in the South Pacific ocean, about 10 miles in circumference; discovered by captain Bligh in 1789. S. lat. 18° 52'. E. long. 200° 19'.

WZETIN. See USETIN.

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